First report of the Royal Commission appointed to inquire into arsenical poisoning [1900] from the consumption of beer and other articles of food or drink.

Contributors

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London School of Hygiene and Tropical Medicine

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ROYAL COMMISSION ON ARSENICAL POISONING.

FIRST REPORT

OF THE

ROYAL COMMISSION

APPOINTED TO INQUIRE INTO

ARSENICAL POISONING

FROM THE CONSUMPTION OF BEER AND OTHER ARTICLES OF FOOD OR DRINK.

Part I.

REPORT.

Presented to both Houses of Parliament by Command of His Majesty.



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THE ROYAL COMMISSION.

EDWARD, R.

Edward the Seventh by the Grace of God, of the United Kingdom of Great Britain and Ireland King, Defender of the Faith.

To Our Right Trusty and Well-beloved William, Baron Kelvin, Knight Grand Cross of the Royal Victorian Order; Our Right Trusty and Well-beloved Councillor Sir William Hart Dyke, Baronet; Our Trusty and Well-beloved Thomas Edward Thorpe, Esquire, Companion of Our Most Honourable Order of the Bath, Principal of the Government Laboratory; Our Trusty and Well-beloved Henry Cosmo Orme Bonsor, Esquire; Our Trusty and Well-beloved William Selby Church, Esquire, Doctor of Medicine, Fellow and President of the Royal College of Physicians of London; and Our Trusty and Well-beloved Benjamin Arthur Whitelegge, Esquire, Doctor of Medicine, Fellow of the Royal College of Physicians of London, Chief Inspector of Factories and Workshops, Greeting!

Whereas We have deemed it expedient that a Commission should forthwith issue to ascertain with respect to England and Wales;

(1) The amount of recent exceptional sickness and death attributable to poisoning by arsenic;

(2) Whether such exceptional sickness and death have been due to arsenic in beer or in other articles of food or drink, and, if so,

(*a*) to what extent;

(*b*) by what ingredients or in what manner the arsenic was conveyed; and

(*c*) in what way any such ingredients became arsenicated, and

(3) If it be found that exceptional sickness and death have been due to arsenic in beer or in other articles of food or drink, by what safeguards the introduction of arsenic therein can be prevented.

Now know ye, that We, reposing great trust and confidence in your knowledge and ability, have nominated, constituted and appointed, and do by these Presents nominate, constitute, and appoint you the said William, Baron Kelvin; Sir William Hart Dyke; Thomas Edward Thorpe; Henry Cosmo Orme Bonsor; William Selby Church and Benjamin Arthur Whitelegge to be our Commissioners for the purposes of the said Inquiry.

And for the better effecting the purposes of this Our Commission We do by these Presents give and grant unto you or any two or more of you, full power to call before you such persons as you shall judge likely

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to afford you any information upon the subject of this Our Commission; and also to call for, have access to, and examine all such books, documents, registers and records as may afford you the fullest information on the subject; and to inquire of and concerning the premises by all other lawful ways and means whatsoever.

And We do by these presents authorise and empower you, or any two or more of you, to visit and personally inspect such places as you may deem it expedient so to inspect for the more effectual carrying out of the purposes aforesaid, and to employ such persons as you may think fit to assist you in conducting any Inquiry which you may hold.

And We do by these presents will and ordain that this Our Commission shall continue in full force and virtue, and that you Our said Commissioners, or any two or more of you, may from time to time proceed in the execution thereof and of every matter and thing therein contained although the same be not continued from time to time by adjournment.

And We do further ordain that you, or any two or more of you, have liberty to report your proceedings under this Our Commission from time to time if you shall judge it expedient so to do.

And Our further will and pleasure is that you do, with as little delay as possible, report to Us under your hands and seals, or under the hands and seals of any two or more of you, your opinion upon the matters herein submitted for your consideration.

And for the purpose of aiding you in your inquiries We hereby appoint Our Trusty and Well-beloved George Seaton Buchanan, Esquire, Doctor of Medicine, to be Secretary to this Our Commission.

Given at Our Court at Windsor the Fourth day of February 1901; in the first year of Our Reign.

By His Majesty's Command,

CHAS. T. RITCHIE.

NAMES OF WITNESSES.

TATTERSALL, Charles H., Medical Officer of Health for the Borough of Salford.

REYNOLDS, Ernest S., M.D., F.R.C.P., Assistant Physician to the Manchester Royal Infirmary; Visiting Medical Officer to the Manchester Workhouse Infirmary

NIVEN, James, M.A., M.D., Medical Officer of Health for the City of Manchester.

HOPE, Edward William, M.D., D.Sc., Medical Officer of Health for the City and Port of Liverpool; Professor of Public Health at the Victoria University.

SALAMON, Alfred Gordon, Consulting and Analytical Chemist; Member of the Expert Committee of the Manchester Brewers' Association.

GROVES, James Grimble, M.P., Chairman and Managing Director of Groves and Whitnall, Limited, Brewers, of Salford and Manchester.

JONES, E. W. T., F.C.S., Public Analyst for the County of Stafford, and for the Boroughs of Wolverhampton, Walsall, Kidderminster, and Newcastle-under-Lyme.

REID, George, M.D., C.M., Medical Officer of Health for the County of Stafford.

STEVENSON, Thomas, M.D., F.R.C.P., Vice-President of the Chemical Society and of the Institute of Chemistry; Lecturer on Forensic Medicine at Guy's Hospital, London; Member of the Expert Committee of the Manchester Brewers' Association.

TATHAM, John, M.A., M.D., Superintendent of Statistics, &c., Office of the Registrar-General.

TUNNICLIFFE, Francis Whittaker, M.D., M.R.C.P., Professor of Materia Medica and Pharmacology at King's College, London.

LUFF, Arthur Pearson, M.D., F.R.C.P., Physician in charge of out-patients at, and Lecturer on Medical Jurisprudence and Public Health at St. Mary's Hospital, London; Member of the Expert Committee of the Manchester Brewers' Association.

TOMSON, Richard George Hooper, Manager of Threlfall's Brewery Company, Limited, Manchester.

MILLER, Alexander K., Consulting Brewers' Chemist, Manchester.

DIXON, Harold B., M.A., F.R.S., Professor of Chemistry at the Owens College, Manchester.

KELYNACK, Theo. N., M.D., M.R.C.P., Medical Officer to the Pendleton Branch of the Salford Royal Hospital; Medical Registrar to the Manchester Royal Infirmary.

KIRKBY, William, Pharmaceutical Chemist, Lecturer on Pharmacognosy at the Owens College, Manchester.

MANN, John Dixon, M.D., F.R.C.P., Professor of Medical Jurisprudence and Toxicology at the Owens College, Manchester.

DEAKIN, W. R., Brewer to the Manchester Brewery Company, Limited, Manchester.

ESTCOURT, Charles, F.C.S., F.I.C., Public Analyst for the City of Manchester and for the Boroughs of Oldham, Macclesfield, &c.

SERGEANT, Edward, M.R.C.S., L.R.C.P., Medical Officer of Health for the County of Lancashire.

SCUDDER, Frank, F.C.S., Consulting Chemist, Manchester.

BURY, Judson S., M.D., F.R.C.P., Physician to the Manchester Royal Infirmary.

BELL, J. Carter, Public Analyst for the County of Chester and for the Boroughs of Salford, Birkenhead, &c.

MORRIS, Herbert N., F.C.S., Chemical Manufacturer, Manchester.

DELÉPINE, Sheridan, M.B., C.M., Professor of Pathology at the Owens College, Manchester,

BLUNDELL, Henry Weld, Chairman of the Cornbrook Brewery Company, Limited, Manchester.

COWELL, George E., Managing Director of Wilson's Brewery Company, Limited, Manchester.

STEIN, Sigmund, Sugar Manufacturers' Chemist, Liverpool.

MARSHALL, William, F.C.S., F.I.C., Public Analyst for the Borough of Hyde.

SPENCER, Henry, Collector of Inland Revenue for the Manchester Collection.

TAYLOR, Henry A., Messrs. H. A. and D. Taylor, Maltsters, Sawbridgeworth and Ware.

O'SULLIVAN, Cornelius, F.R.S., Messrs. Bass, Radcliffe and Gretton, Limited, Burton-on-Trent.

BRUNTON, Sir Lauder, M.D., F.R.C.P., F.R.S., Physician to St. Bartholomew's Hospital, London, Member of the Expert Committee of the Manchester Brewers' Association.

GARTON, Richard Charles, Messrs. Garton, Hill and Company, Brewing Sugar Manufacturers, Battersea.

RAW, Nathan, M.D., Medical Superintendent of the Mill Road Infirmary, Liverpool.

DAVIS, Geo. E., F.I.C., Chemical Engineer, Consulting Chemist of the Manchester Technical Laboratory.

PRIMROSE, Sir Henry W., K.C.B., C.S.I., Chairman of the Board of Inland Revenue.

CAMPBELL-BROWN, James, D.Sc., Professor of Chemistry at University College, Liverpool; Head of the County and City Laboratory, Liverpool, and Public Analyst.

LOVIBOND, Thomas Watson, F.I.C., Managing Director of the Newcastle Breweries, Limited.

EARP, Thomas, Messrs. Gilstrap and Earp, Maltsters, Newark-on-Trent.

BRIANT, Lawrence, F.C.S., Brewers' Analyst, representing the Chemical Manufacturing section of the Brewery Traders' Association, London.

WILLIAMSON, Edward, late Secretary of Bostock and Company, Limited, of Garston and Liverpool.

FRANCIS, E. G., Manager of the Manbré Saccharine Company, Limited, Fulham.

WAHL, Rudolph Frederick, Managing Director, Nord-Deutsche Kartoffel-Mehl Fabrik, Cüstrin, Prussia.

BERRY, Walter W., Hop Grower, Faversham.

BAIRD, Hugh, Maltster, Glasgow.

HOOPER, Egbert Grant, F.C.S., F.I.C., Analyst in the Government Laboratory.

HEHNER, Otto, F.I.C., Public Analyst for the Counties of Nottingham, West Sussex, the Isle of Wight, and for the Boroughs of Derby and Ryde.

READ, Clare Sewell, Representing the Central and Associated Chambers of Agriculture.

STOPES, Henry, Representing the Central and Associated Chambers of Agriculture.

The following have submitted written statements to the Commission, but have not been examined thereon :—

NICHOLSON, Joseph, Director of Nicholson and Sons, Limited, Chemical Manufacturers, Hunslet, Leeds.

WILLIAMSON, Edward, late Secretary of Bostock and Company, Limited, Brewing Sugar Manufacturers, Garston and Liverpool.

MORRIS, G. Harris, PH.D., F.C.S., F.I.C., Consulting Brewers' Chemist, London.

REPORT OF THE COMMISSION ON ARSENICAL POISONING.

To the King's Most Excellent Majesty.

May it please your Majesty,

We, the undersigned Commissioners, appointed on February 4th last to inquire into the subject of arsenical poisoning, do humbly submit to your Majesty the following Report:—

We have now held 18 sittings in London and in Manchester, and we have examined fifty-one witnesses. The subject which your Majesty has referred to the Commission involves various administrative, scientific, and technical questions, which it is necessary for us to pursue further. We think, however, that a stage has been reached at which it is well for us to avail ourselves of your Majesty's gracious permission to report our proceedings from time to time, and to summarise in a first Report the conclusions at which we have arrived from the evidence already received. This we propose to do under the following heads:—

A.—The extent of recent exceptional sickness and death in England and Wales attributable to poisoning by arsenic.

B.—The causation of this recent epidemic of poisoning by beer which had become contaminated by arsenic.

C.—Certain medical and toxicological aspects of this epidemic.

D.—Arsenic in beer previous to this epidemic.

E.—Ways in which arsenic is liable to gain access to beer.

F.—Arsenic-free beer.

G.—Arsenic in articles of food and drink other than beer.

H.—Administrative considerations.

A.—*The extent of the recent exceptional sickness and death in England and Wales attributable to poisoning by arsenic.*

(1) During the latter part of 1900 there occurred in England and Wales exceptional sickness and death attributable to poisoning by arsenic. This sickness, which assumed epidemic proportions, has principally affected districts in Lancashire and Staffordshire, but its incidence has not been confined to those counties. The epidemic appears to have attacked Manchester and its neighbourhood more seriously than elsewhere. In the County Boroughs of Manchester and Salford alone the Medical Officers of Health estimate that at least 3,000 persons suffered by it.

(2) By inviting the co-operation of Medical Officers of Health throughout the country, by seeking information from the Statistical Department of the Office of the Registrar General, and in other ways, the Commission has taken steps to obtain information as to the extent, local distribution, and fatality of this exceptional sickness.

B.—*The causation of the recent epidemic of arsenical poisoning.*

(3) The evidence which we have received from physicians, medical officers of health, and others, has been uniformly to the effect that this epidemic sickness and death was attributable to beer which had become contaminated with arsenic at numerous breweries; that when, at the end of November, 1900, arsenic was indicated by Dr. E. S. Reynolds, of Manchester, as the cause of the epidemic in that city, beer from these breweries

was tested in a large number of instances, and arsenic was detected in dangerous proportions; that on the discovery of arsenic, steps were immediately taken by brewers and by sanitary authorities to ensure that this arsenical beer was withdrawn from sale; that this was done, usually with commendable rapidity, in all the districts from which we have received evidence, and that, as a result, the epidemic came speedily to an end.

(4) The evidence which we have received from Medical Officers of Health and others has shown that in all instances where this epidemic of sickness has been traced to beer from particular breweries, the latter have been users of brewing sugars supplied by a single firm, Bostock and Co., Limited, of Garston, near Liverpool. We use the term "brewing sugars" in this connection to comprise the two substances glucose and "invert sugar," which are extensively used in breweries as adjuncts to or as partial substitutes for malt, and as "priming" solutions which are added after the fermentation of the wort.

The quantity of arsenic detected in specimens of the above mentioned brewing sugars, by chemists who have given evidence to the Commission, has been relatively large.

In samples of Bostock glucose taken from breweries last November arsenic, as arsenious oxide, has been estimated as follows:—By Professor Delépine, of Owens College, Manchester, in several samples, from ·015 per cent. to ·095 per cent. (1·05 to 6·6 grs. per lb.) by Mr. E. W. T. Jones, Public Analyst of Staffordshire, in a single sample, ·023 per cent. (or 1·6 grs. per lb.); by Professor Campbell Brown, of University College, Liverpool, in several samples, from ·008 to ·131 per cent. (·56 to 9·17 grs. per lb.).

Samples of Bostock glucose which had been obtained from breweries for purposes of Excise between June and September 1900, have been found at the Government Laboratory to contain from ·013 per cent. (·89 grains per lb.) to ·047 per cent. (3·28 grains per lb.).

With regard to Bostock invert sugar, samples taken from breweries last November have been found to contain arsenious oxide to the extent of ·02 per cent. (1·4 grains per lb.) by Professor Delépine, and ·062 per cent. (4·34 grains per lb.) by Professor Campbell Brown.

Samples of Bostock invert sugar obtained from breweries between September and December have been found at the Government Laboratory to contain from ·024 per cent. (1·66 grains per lb.) to ·046 per cent. (3·21 grains per lb.).

(5) The implicated Bostock brewing sugars became thus seriously contaminated by arsenic in course of their manufacture through the use of sulphuric acid supplied by a single firm of acid makers, Nicholson and Sons, Limited, of Leeds.

The amount of arsenic which has been estimated by witnesses to the Commission in specimens of Nicholson acid taken from Bostock's works in November was exceptionally high. In one such specimen Professor Harold Dixon, of Owens College, Manchester, estimated the arsenious oxide at 1·5 per cent.; in another specimen, Dr. Stevenson, of Guy's Hospital, estimated 1·4 per cent.; in five additional specimens, Professor Campbell Brown estimated amounts between 1·92 per cent. and 2·6 per cent. of arsenious oxide.

(6) We have had before us representatives of Bostock and Co. and of Nicholson and Sons, who in each instance have furnished us with a statement of the position of their firm in this matter. From these statements we understand that it is admitted by Messrs. Nicholson that from February to November, 1900, they supplied Messrs. Bostock with acid that must have contained arsenic; that Messrs. Nicholson did not inform Messrs. Bostock of the fact that the acid supplied by them during this period must needs have been arsenical, and they state that they did not know the purpose for which it was required. Further, we gather that Messrs. Bostock, who had been customers of Messrs. Nicholson for several years, appear to have systematically used the arsenical acid supplied to them from February to November, 1900, by Messrs. Nicholson in the preparation of brewing sugars without attempting to ascertain whether or not the acid contained arsenic, being under the impression that they were regularly receiving a pure acid made from brimstone.

(7) The firm of Bostock and Co. is now in liquidation, and an action for damages has been commenced by the Official Liquidators, on behalf of the creditors of that company, against the firm of Nicholson and Sons. Having regard to the terms of our reference, and also to the fact that the transactions between these firms are about to come before a court of law, we have not sought by pursuing inquiry into this matter to apportion between these two firms, or between individuals, the responsibility for the acts of omission or commission which have entailed serious sickness and loss of life to so many of your Majesty's subjects.

(8) So far as the Commission has at present learned, the proportion of glucose and invert sugar used in the production of the beers which were associated with the epidemic, was as a general rule no greater than those which are used in many other English breweries. And mischief appears to have been caused by some beers in which Bostock products constituted only a portion of the total brewing sugars used in their preparation.

(9) The amount of arsenic present in beers brewed with arsenical Bostock sugars must have varied widely at different breweries and in different kinds of beer. Not only did the proportion of these sugars used in different brews vary greatly, but there is further material difference due to the stage at which the sugar was introduced into the beer. The evidence goes to show that in the process of brewing a portion of the arsenic contained in arsenical brewing sugar added before fermentation will be removed by the action of yeast, and possibly also in other ways; whereas, if arsenical sugars are introduced as "priming," after the beer has left the fermenting vessels, the whole of the arsenic present in the "priming" solution will apparently remain in the beer.

(10) The quantities of arsenic reported to the Commission as having been found in specimens of beer brewed with Bostock sugar has been, in exceptional cases, as high as about $1\frac{1}{3}$ grains per gallon, and in one sample no less than 3 grains per gallon have been detected. As a rule, however, the proportion of arsenic in beers presumably associated with the production of the epidemic has been estimated at a lower figure, *e.g.*, 1 to $\frac{1}{2}$ to $\frac{1}{4}$ of a grain per gallon, or less.

Conclusion as to the exact amount of arsenic present in the inculpated beers is rendered difficult by the fact that different analysts have employed different methods which in some instances have produced very divergent results when applied to samples of the same beer. We propose to make further inquiry into the relative value of different quantitative tests for arsenic in beer, as to the most trustworthy methods to recover all the arsenic present in a given sample of beer, and as to the possible existence of arsenic in beer in some combination with organic matter in which it might escape determination by certain of the tests commonly employed.

(11) It has been stated to us by one witness, Dr. Tunnicliffe, that he has detected a relatively considerable quantity of selenium in a sample of Nicholson acid—not, however, coming from Bostock's—in a sample of Bostock glucose, and in a sample of beer which had been manufactured with Bostock brewing sugars. This circumstance, taken along with the suggestion which he obtained from the toxic effect of selenium upon lower animals, led Dr. Tunnicliffe to infer that poisoning by selenium as well as by arsenic might have been an important factor in the epidemic.

We have, however, received no confirmatory evidence that selenium has been present in Nicholson's acid as supplied to Messrs. Bostock in any quantity approaching that determined by Dr. Tunnicliffe. We have received no confirmatory evidence of the detection of selenium in samples of Bostock brewing sugars, or of Bostock-brewed beer; on the contrary, the absence of selenium from these substances has apparently been proved in a considerable number of instances. On this subject we have evidence that since this suggestion by Dr. Tunnicliffe, search has been made for selenium in many samples of beer and brewing ingredients which had no relation with Bostock sugars, but in no case has selenium been found.

C.—*Medical and Toxicological Aspects of the epidemic.*

(12) The persons who have suffered by the epidemic in many instances have been ascertained to be heavy drinkers of beer. Nevertheless it is clear that others have suffered who probably drank quite moderate amounts of beer which there is no reason to believe was more arsenical than that which produced illness in heavy drinkers.

In this connection we have received reports of researches as to the presence of arsenic in excretions of sufferers by the epidemic, in their skin and hair, and in their organs post-mortem, which have been important as constituting additions to medical knowledge of the affinity which certain tissues of the body apparently possess for arsenic, and which indicate that in certain conditions the elimination of arsenic may take place more slowly than has been hitherto generally supposed.

(13) In our opinion the evidence obtained with regard to the epidemic suggests caution as necessary in comparing the effect of arsenic in small quantities taken at irregular intervals along with beer and in uncertain relation to food, with the effect of its medicinal administration under medical supervision.

(14) It is necessary to draw attention to this further circumstance. Among the beer drinkers attacked by the epidemic were many whose symptoms were hardly, if at all, to be distinguished from those of the disease known as "alcoholic peripheral neuritis," which hitherto it has been customary to associate with the consumption of large quantities of alcohol by spirit drinkers. Yet the persons attacked with disease closely simulating alcoholic peripheral neuritis were not in all cases heavy drinkers, nor was there reason to doubt that in their case arsenic in beer had been the essential cause of the illness.

We have been informed by certain physicians in Manchester and Salford that from their local experience of alcoholic peripheral neuritis, they had before the 1900 epidemic come to regard this disease as essentially one which affected beer drinkers. In this connection, too, the evidence suggests that in Manchester and Salford, for some years before 1900, "alcoholic peripheral neuritis" has been more common than in large towns in other parts of the country where, so far as is known, excessive drinking is no less common than in Manchester. We hope to obtain further facts with regard to this suggestion.

D.—*Arsenic in Beer previous to the epidemic.*

(15) Although the liability of beer to contain arsenic was not recognised before the epidemic, we cannot doubt that beer other than that brewed with the contaminated Bostock's brewing sugars of 1900, has in the past contained arsenic.

Since the epidemic arsenic has been estimated, occasionally in quantities such as $\frac{1}{10}$ grain per gallon, and frequently in smaller amounts such as $\frac{1}{30}$ to $\frac{1}{100}$ grain, in the case of beers coming from certain breweries where Bostock's ingredients had not been used.

E.—*Ways in which Arsenic is liable to gain access to Beer.*

(16) We have received evidence that arsenic may be introduced into beer:—

(a) *By way of brewing sugars.*—The epidemic has clearly demonstrated that if the mineral acid employed in the manufacture of glucose from starch, or of "invert sugar" from cane sugar, has been arsenical, beer prepared from these ingredients can become dangerously contaminated by arsenic.

We have received no evidence which suggests that in the manufacture of brewing sugars other firms have permitted such a degree of risk as that which led to disaster in the case of Bostock and Co.; on the contrary, important firms of brewing sugar makers have testified that it has been their custom for many years past to take precautions to obtain a pure acid, and to test their acid for arsenic.

A large number of samples of brewing sugars of home and foreign manufacture—not from Bostock's—which were on the market before the discovery of the cause of the epidemic, have been examined by different analysts, and they nearly always have been found free from arsenic. In a few exceptional cases arsenic has been found, although in relatively small amounts. These exceptional cases include a sample of glucose which was found at the Government Laboratory to contain ·09 of a grain of arsenious oxide per pound, and single samples of glucose or invert sugar in which arsenic has been detected by Professor Delépine, Mr. Gordon Salamon, and Professor Campbell Brown. Arsenic has been detected by three analysts in three separate samples of imported German glucose.

We have also received evidence of the presence of arsenic in specimens of caramel not coming from Messrs. Bostock.

(b) *By way of malt.*—In the British system of malting, the grain is exposed to the products of combustion of the fuel when on the kiln. We are satisfied that by use of fuel containing arsenic material quantities of arsenic may be deposited on malt and so reach beer.

(c) *In other ways.*—Other ingredients of beer, such as chemical substances used for various purposes, are liable from their mode of preparation to contain arsenic, and we have found that minute quantities have been in some instances introduced in this way.

(17) We are of opinion that access of arsenic to beer by means of these ingredients is avoidable.

(18) As regards brewing sugars and other ingredients where the source of risk is mineral acid, such as sulphuric acid, we have evidence that such acid can be obtained as a commercial article free from arsenic. It is quite practicable for manufacturers so to test every consignment as to insure the uniform freedom from arsenic of the acid which they use, and also, as a further check, to seek systematically for arsenic in their finished products. We have reason to believe that stringent precautions in these respects have now been adopted by British manufacturers of brewing sugars, and have suggested below administrative measures to secure that brewing glucose and invert sugar, of whatever origin, should be uniformly free from arsenic.

(19) More knowledge of the liability of fuels suitable for malting to contain arsenic is needed, and concerning this point, and the Government Department upon whom responsibility for the protection of the consumer from risk in this respect should ultimately rest, we propose to receive further evidence. Meanwhile we have reason to believe that this subject is being studied by maltsters with the view to adoption of the most suitable precautions to avoid risk of the access of arsenic to their malt.

If malt be dried by hot air, for example in cylinders or on kilns with impervious floors, the products of combustion do not reach the grain at any stage, and no risk of arsenic passing from fuel to malt is run. We have, however, had evidence from maltsters that they regard attempts to employ hot air in place of the fumes of the fire as commercially impracticable, not merely because of the large expense which would be entailed in reconstructing their kilns, and from the difficulty anticipated in suitably regulating the temperature and dissemination of the heated air, but also because they imagine that the products of combustion of fuel are necessary to give to malt a flavour which is needed to produce beer which is satisfactory to the consumer. We have not, however, received any experimental evidence tending to support this last contention.

We are of opinion that the use in the malting kiln of fuel selected on account of its freedom from arsenic, supplemented by a careful process of screening, brushing, and cleansing of the malt, will insure the protection of the public from danger due to the presence of arsenic in malt.

(20) As regards ingredients of beer other than brewing sugars and malt which are liable from their mode of preparation to contain arsenic, we are satisfied that by the exercise of care in the selection of these materials no risk of introduction of arsenic into the beer need arise.

(21) We have learned that search for arsenic has been made in a large number of samples of hops. In nearly every case they have been found free from arsenic, but in rare instances very minute amounts of arsenic have been detected. As hops on the kiln are exposed to the products of combustion of the fuel, it is desirable that the hop drier should exercise care in the selection of the fuel which he uses.

F.—*Arsenic-free Beer.*

(22) In our view the facts of the recent epidemic indicate that the presence of minute quantities of arsenic in beer should not be disregarded from the view-point of public health. It is not only essential to prevent gross contamination by arsenic such as occurred by the use of Bostock brewing sugars in 1900, but also it is desirable and practicable to obviate the access of arsenic to beer even in minute amount by way of any of its ingredients and thus to produce arsenic-free beer. We are satisfied from the evidence that since the epidemic precautions in this direction have been very generally adopted by brewers and others.

(23) It may be objected that it is hardly practicable to produce beer that can correctly be termed "arsenic-free" on the grounds that arsenic is a widely distributed element, that some tests for it are very delicate, and that any beer, however carefully prepared, would, if examined in sufficient quantity, be liable to show minute traces of arsenic.

That there is some force in this objection may be admitted. But in the absence of fuller knowledge than is at present available as to the possible effect of consumption of mere traces of arsenic, we are not prepared to allow that it would be right to declare any quantity of arsenic, however small, as admissible in beer or in any food, and we think it should be the aim of the manufacturer to exclude arsenic altogether.

As regards beer, we recognise the desirability of ultimately defining, in terms of a standard quantity of beer and of a standard test, a proportion of arsenic to be regarded as altogether inadmissible, so that there should be no cause for hesitation on the part of the public authorities or of the brewer in taking steps to prevent beer which transgresses this standard from being consumed by the public. To this extent the desired "freedom from arsenic" may be defined for administrative purposes by a standard test.

We have evidence that at the present moment analysts are by no means agreed as to the most efficient test to detect minute quantities of arsenic in beer. In view of these circumstances we consider it essential to institute further inquiry before recommending the standard test which should be imposed.

G.—*Arsenic in Articles of Food and Drink other than Beer.*

(24) We have received no evidence tending to show that articles of food or drink other than beer have been concerned in the recent epidemic. We have received information from analysts who have lately examined certain articles and ingredients of food and drink for arsenic, and have learnt that the results of these examinations have on the whole been negative. In instances which have so far come before us where arsenic has been detected, the amounts reported have been minute, and have not seemed to indicate material danger to public health.

(25) In our opinion, however, it would be unwise to assume that particular articles of food are free from risk of arsenical contamination because certain samples examined at a particular time have been found free from arsenic. In view of the circumstances associated with the recent epidemic, it is clearly necessary also to know whether or not in the case of a given article of food there is risk of access of arsenic owing to lack of knowledge or of care on the part of the manufacturer, and to determine the extent of risk in the absence of suitable precaution. By inviting the co-operation of public analysts throughout the country and in other ways we are taking steps to obtain further information upon this subject.

H.—*Administrative considerations.*

(26) In pursuance of the last paragraph of our reference, we have sought to ascertain how far the recurrence of such a catastrophe as the epidemic of 1900 may be avoided in future through the action of existing authorities:—

(*a*) Under the sale of Food and Drugs Acts, by the County or Borough Councils who are the authorities under those Acts, or by their public analysts;

(*b*) Under the Public Health Acts, by Town Councils or Urban and Rural District Councils, or by their medical officers of health;

(*c*) Under the Revenue Acts, which it is obvious can in any case afford security only as regards articles subject to duty, by officers of the Revenue.

With regard to the above-mentioned Acts and authorities we think it well to draw attention to the following points which have come before us in investigating the circumstances of the recent epidemic:

(27) *(a) Sale of Food and Drugs Acts.*—We have heard of no instances in which samples of brewing sugar have been collected for public analysis under these Acts. After the epidemic public analysts did indeed in some cases obtain samples from breweries informally, but officers under the Sale of Food and Drugs Acts appear to have no statutory powers to collect samples of brewing sugars either from the factory or from the brewery.

Similarly, in the case of beer no samples have been collected for public analysis from breweries. Officers under the Acts possess power to obtain samples only when the beer is actually on sale. In practice authorities under the Sale of Food and Drugs Acts appear to have found that they possess no effective powers as against the sugar manufacturer or as against the brewer, and they have been obliged to institute proceedings against the retailer.

(28) We have learnt that, until the epidemic occurred, neither the public analysts nor others concerned were aware of the liability of beer to contain arsenic, and consequently they had applied no test to beer for its discovery.

It is not always recognised as a duty of a public analyst to advise his authority of the articles of food or drink which are liable to become contaminated with poisonous substances such as arsenic whilst in process of manufacture or in preparation for sale. For the most part his duty is understood to consist in analysing articles of food or drink sent to him officially under the Sale of Food and Drugs Acts, in order to ascertain if they are genuine and free from adulteration. The nature and number of such samples are not necessarily determined on the advice of the public analyst, but appear to depend upon a number of varying local circumstances largely outside his control. We are also informed that it is not the practice of any Government Department or other central body to do more than tender general advice to authorities under the Sale of Food and Drugs Acts concerning these matters.

(29) When the contamination of beer by arsenic became known, and public analysts had to examine large numbers of samples for arsenic and to express their results quantitatively, much uncertainty followed from the adoption of different methods and from lack of data by which to compare the divergent results obtained. Hence demand has arisen that some authority should prescribe standard tests for arsenic, which might be adopted or used for reference by all public analysts. It does not at present fall within the province of any public authority to formulate standard tests such as are demanded.

(30) (*b*) *Public Health Acts.*—We have heard of no instances in which official action under the Public Health Acts to obtain the seizure, condemnation, or destruction of arsenical brewing sugar on the premises of the sugar manufacturer or of the brewer has been considered practicable. Nor have we learnt of any case in which such action has been taken in respect of arsenical beer at a brewery. In the opinion of most of the witnesses whom

we have examined on this point, the provisions of the Public Health Act, 1875, and of the Public Health Acts Amendment Act, 1890, which enable officers of local authorities under certain conditions to obtain the condemnation and destruction of unsound articles of food, could not have been utilised for the above purposes.

We think it right to state, however, that we have evidence that informal action by medical officers of health, and steps which were taken by those who found their business implicated, sufficed to obviate much of the difficulty and risk which might otherwise have arisen through lack of statutory power in these respects.

(31) (*c*) *Revenue Acts.*—These Acts have hitherto afforded no power of inspection or control over the manufacture of brewing materials, and (unlike the Sale of Food and Drugs Acts, and the Public Health Acts) they have no application to articles of food and drink which are not subject to duty.

As regards breweries, it is not in practice accepted as part of the ordinary duty of officers of the Inland Revenue to acquire knowledge of the nature or origin of brewing materials to any further extent than may be necessary to safeguard the interests of the Revenue. Similarly, the function of the Government Laboratory, when dealing with samples of brewing materials sent to them by officers of Revenue for examination, has hitherto been rather the determination of their brewing value for purposes of preventing fraud on the Revenue, than of their quality or freedom from substances injurious to health.

(32) By the Customs and Inland Revenue Act of 1888, the Commissioners of the Treasury have been empowered to prohibit by publication of notice in the *London Gazette*, the use in the manufacture or preparation for sale of any article subject to a duty of excise, of "any substance or liquor of a noxious or detrimental nature," or which, "being a chemical or artificial extract or product, may affect prejudicially the interests of the Revenue." By the same Act a person using any substance thus prohibited in the manufacture or preparation for sale of any article specified in the published notice is subject to penalty. We have learned that in practice this provision has come to be generally regarded as one essentially designed to protect the Revenue. It has not been made altogether clear that the provision would cover the prohibition of arsenicated brewing materials. The only article which has been scheduled at the instance of the Board of Inland Revenue for exclusion from breweries has been saccharin, which has been so treated for Revenue reasons.

(33) On consideration of all the circumstances connected with the recent epidemic, we think that some improvement in administrative measures is called for. It is evident that amendments have to be considered, not only with reference to the question of arsenic in beer, but also in relation to the broader question of the machinery available to public health authorities to obviate risk of arsenic or other poisonous substance reaching articles of food and drink in general.

Upon this important general question we consider it essential to await further evidence before making final recommendations. But meanwhile, seeing that the epidemic of 1900 has been caused solely by beer, and that there exists in the case of breweries (although for another purpose) a system of close inspection by a Government Department—the Board of Inland Revenue—we think that as a provisional measure the machinery under this system might effectively be turned to account to check the introduction of arsenic into beer by way of its ingredients.

(34) To this end we recommend that the Board of Inland Revenue should possess and should exercise powers to specify in detail individual ingredients of beer which are liable from their origin or mode of preparation to be contaminated by arsenic, to prescribe for every such ingredient, and for the different materials used in their preparation, an adequate test which should ensure their freedom from arsenic, and to prohibit, under penalty, the use in a brewery of any material which infringes the prescribed test.

We are of opinion that by requiring the brewer to produce satisfactory evidence (whether in the form of a guarantee from the vendor, or as the result of analysis by the brewer's chemist, stated in such terms as the Board of Inland Revenue may determine) that the prescribed tests have been applied to all the ingredients of beer at the brewery which have been specified as liable to contain arsenic, and that by the examination of samples in the Government Laboratory, an immediate and effective safeguard to the public with regard to arsenic in beer can be secured.

All which we humbly submit for your Majesty's gracious consideration.

(Signed) KELVIN,
Chairman.

W. HART DYKE.

W. S. CHURCH.

T. E. THORPE.

H. COSMO BONSOR.

B. A. WHITELEGGE.

G. S. BUCHANAN,
Secretary.

6 July 1901.

MEMORANDUM BY DR. WHITELEGGE.

I concur in the Report except one portion of paragraph 34.

The excise officers visit breweries, and will in future habitually visit certain brewing sugar factories in this country, for revenue purposes. I concur fully in the recommendation that as regards those places, and all materials found there, they should utilise their opportunities of supervision with a view to secure freedom from arsenic, and that in order to make the control effective, the Board of Inland Revenue should possess and exercise power to prescribe and enforce a standard chemical test for any of the above materials that lend themselves to it. Samples could then be taken from bulk for official analysis; and indeed a check of this kind would seem to be essential for the purpose.

But the wide terms of the recommendation in paragraph 34 include more remote materials, not to be found in the brewery or the sugar factory, such, for example, as the fuel which has been used in malting. Whatever may ultimately prove to be the right course, I venture to think that at the present stage of the inquiry, and in a provisional recommendation, the reference of administration and standards to the Board of Inland Revenue should be limited to materials found upon the premises visited for revenue purposes.

In the instance I have given, unless the excise officers undertake the supervision of malting premises, they cannot see or sample the fuel in use there; and if reliance is to be placed upon their inspection at the brewery of certificates relating to fuel already consumed at the maltsters, the official control ceases to be effective, for the certificate cannot even be linked in any practical way with the fuel to which it relates.

And further, it remains to be determined by the Commission whether careful selection of fuel as regards its nature and origin, or subjection of it to some safeguarding process, would not afford to the maltster a surer basis of precaution than reliance upon certificates of compliance with a standard chemical test, the value of which in practice must depend upon the proper choice of samples taken from a large bulk of fuel. No evidence upon this point has yet been received, and the Commission, as stated in paragraph 19, propose to institute further inquiries.

In the circumstances, I cannot but regard this part of the recommendation in paragraph 34 as premature.

(signed) B. A. WHITELEGGE.

10 July 1901.

Dr Reece,
with compliments.
J. Buchanan.
Dec: 3/03.

FINAL REPORT

OF THE

ROYAL COMMISSION

APPOINTED TO INQUIRE INTO

ARSENICAL POISONING

FROM THE CONSUMPTION OF BEER AND OTHER ARTICLES OF FOOD OR DRINK.

Part I.

FINAL REPORT.

Presented to both Houses of Parliament by Command of His Majesty.



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THE ROYAL COMMISSION.

EDWARD, R.

Edward the Seventh by the Grace of God, of the United Kingdom of Great Britain and Ireland King, Defender of the Faith.

To Our Right Trusty and Well-beloved William, Baron Kelvin Knight Grand Cross of the Royal Victorian Order; Our Right Trusty and Well-beloved Councillor Sir William Hart Dyke, Baronet; Our Trusty and Well-beloved Thomas Edward Thorpe, Esquire, Companion of Our Most Honourable Order of the Bath, Principal of the Government Laboratory; Our Trusty and Well-beloved Henry Cosmo Orme Bonsor, Esquire; Our Trusty and Well-beloved William Selby Church, Esquire, Doctor of Medicine, Fellow and President of the Royal College of Physicians of London; and Our Trusty and Well-beloved Benjamin Arthur Whitelegge, Esquire, Doctor of Medicine, Fellow of the Royal College of Physicians of London, Chief Inspector of Factories and Workshops, Greeting!

Whereas We have deemed it expedient that a Commission should forthwith issue to ascertain with respect to England and Wales;

(1) The amount of recent exception sickness and death attributable to poisoning by arsenic;

(2) Whether such exceptional sickness and death have been due to arsenic in beer or in other articles of food or drink, and if so,

(*a*) to what extent;

(*b*) by what ingredients or in what manner the arsenic was conveyed; and

(*c*) in what way any such ingredients became arsenicated, and

(3) If it be found that exceptional sickness and death have been due to arsenic in beer or in other articles of food or drink, by what safeguards the introduction of arsenic therein can be prevented.

Now know ye, that We, reposing great trust and confidence in your knowledge and ability, have nominated, constituted, and appointed; and do by these Presents nominate, constitute, and appoint you the said William, Baron Kelvin; Sir William Hart Dyke; Thomas Edward Thorpe; Henry Cosmo Orme Bonsor; William Selby Church and Benjamin Arthur Whitelegge to be our Commissioners for the purposes of the said Inquiry.

And for the better effecting the purposes of this Our Commission We do by these Presents give and grant unto you or any two or more of you, full power to call before you such persons as you shall judge likely

4576. 3,000.—Wts. 28817 & 27987.—12/03. Wy. & S.

to afford you any information upon the subject of this Our Commission and also to call for, have access to, and examine all such books, documents registers and records as may afford you the fullest information on the subject; and to inquire of and concerning the premises by all other lawful ways and means whatsoever.

And We do by these presents authorise and empower you, or any two or more of you, to visit and personally inspect such places as you may deem it expedient so to inspect for the more effectual carrying out of the purposes aforesaid, and to employ such persons as you may think fit to assist you in conducting any Inquiry which you may hold.

And We do by these presents will and ordain that this Our Commission shall continue in full force and virtue, and that you Our said Commissioners, or any two or more of you, may from time to time proceed in the execution thereof and of every matter and thing therein contained although the same be not continued from time to time by adjournment.

And We do further ordain that you, or any two or more of you, have liberty to report your proceedings under this Our Commission from time to time if you shall judge it expedient so to do.

And Our further will and pleasure is that you do, with as little delay as possible, report to Us under your hands and seals, or under the hands and seals of any two or more of you, your opinion upon the matters herein submitted for your consideration.

And for the purpose of aiding you in your inquiries We hereby appoint Our Trusty and Well-beloved George Seaton Buchanan, Esquire, Doctor of Medicine, to be Secretary to this Our Commission.

Given at Our Court at Windsor the Fourth day of February 1901; in the first year of Our Reign.

By His Majesty's Command,

CHAS. T. RITCHIE.

FINAL REPORT

OF THE

ROYAL COMMISSION ON ARSENICAL POISONING.

To the King's Most Excellent Majesty.

May it please your Majesty,

We, the undersigned Commissioners, appointed on February 4th, 1901, to enquire into the subject of Arsenical Poisoning, do humbly submit to your Majesty our final Report.

1. In our First Report, presented in July, 1901, we set out the conclusions at which we had arrived from the evidence then received, and stated that we considered it necessary to pursue our inquiry into various administrative, scientific, and technical questions which had arisen. Since that date we have held numerous sittings, and have examined 29 witnesses, several of whom have submitted reports of scientific researches undertaken during the past two years, by themselves or by Societies or Committees whom they represented, which have been of much value to our inquiry. We have also invited and obtained information from medical officers of health, public analysts, and other officers of local public health authorities, and we have caused investigations to be conducted for our assistance.

2. In the following Report we give marginal references to Minutes of Evidence and Appendix Papers, contained in two volumes. Vol. I. comprises Evidence and Appendix Papers relating thereto received up to July, 1901, when our First Report was presented. Vol. II. comprises all Evidence, Appendix Papers and Reports received since that date. *Marginal references to the latter volume are in italic type.*

3. As in our First Report, we use for convenience the general term "food" to include also articles of drink. Where quantities of arsenic are stated, the figures given refer to arsenic reckoned as arsenious oxide.

4. We propose to report under the following heads :—

Part I.—Further observations regarding the epidemic of arsenical poisoning in 1900, and as to the medical and public health aspects of the evidence received regarding arsenic in beer and food.

Part II.—The suggested relation between the disease "beri-beri" and arsenical poisoning.

Part III.—Tests for arsenic in foods and substances used in the preparation or manufacture of food.

Part IV.—Ways in which foods are liable to become contaminated by arsenic.

PART V.—Precautions which should be taken by manufacturers to exclude arsenic from foods.

PART VI.—Present means of official control over purity of food, in relation to arsenic.

PART VII.—Recommendations as to improvements in official control over the purity of food.

PART VIII.—Recommendations as to the proportions of arsenic in food which should now be held to constitute an offence under the Sale of Food and Drugs Acts.

PART I.

FURTHER OBSERVATIONS REGARDING THE EPIDEMIC OF ARSENICAL POISONING IN 1900, AND AS TO THE MEDICAL AND PUBLIC HEALTH ASPECTS OF THE EVIDENCE RECEIVED REGARDING ARSENIC IN BEER AND FOOD.

Causation of the Epidemic of 1900.

5. In our First Report we dealt in some detail with the evidence received as to the cause of the serious epidemic of poisoning which occurred in the latter part of 1900, and which led to the appointment of this Commission. As we then showed, the epidemic, as such, was due to arsenical contamination of beer at numerous breweries through the use of brewing sugars, glucose or "invert" sugar manufactured by a single firm, that of Bostock & Co., of Garston, near Liverpool. The arsenic was introduced into Bostock's brewing sugars, by way of a highly arsenical sulphuric acid, which had been used in their manufacture for some eight or nine months before the date on which it was first suspected that the sugars in question had been the means of producing poisoning by reason of the beer prepared from them. The arsenical sulphuric acid had been supplied to Bostock & Co. by the firm of Nicholson and Sons, chemical manufacturers, of Leeds. As regards the cause of the epidemic, and the steps taken by public health authorities, brewers, and others to bring it to a speedy termination, we have nothing to add to our former report.

Disposal of Bostock's Brewing Sugars.

6. Shortly after the appointment of the Commission, we learnt that the firm of Bostock and Co. was in liquidation. Realising the importance of preventing any risk of further poisoning, we requested the liquidators to keep the Commission informed of the action taken when the large stock of glucose and "invert" sugar remaining at the works (over 700 tons) came to be disposed of. In May, 1901, however, evidence which we received from the former Secretary of the Company regarding the precautions which had been adopted in selling the small amount of contaminated glucose which had then already left the works, and the result of inquiries by Mr. H. Hammond Smith, who visited Bostock's factory on our behalf, seemed to us unsatisfactory. We therefore at once made strong representations to the official liquidators and communicated with the Local Government Board, who instituted inquiries.

Williamson, 7300-32. *H. Smith, 10982.*

As a result of this action, very stringent precautions were adopted by the liquidators. By November, 1901, all the contaminated glucose and "invert" sugar had been sold, and had been consigned directly to manufacturers for use in textile and other purposes unconnected with food; particulars regarding each sale, and the undertakings entered into respecting the use of all sugars sold, having been systematically communicated by the liquidators to the Commission and to the Local Government Board.

Bostock's "Table Syrup."

7. In 1900, Messrs. Bostock & Co. had commenced to manufacture preparations resembling treacle, termed "Table Syrups." These were flavoured with various fruit essences and put up in 2-lb. tins for sale. The syrup used was cane sugar which had been "inverted" by Nicholson's sulphuric acid. Fortunately, at the date of the discovery of arsenic in their brewing sugars scarcely any of these table syrups were on the market. A trial series of tins had been sent out to retailers, but in most instances the syrup in the tins was found to have become

H. Smith, 10971-82. Appx. 25, p. 765.

solidified through some accident in the manufacture, and in consequence the bulk of the tins had been returned to the factory. In May, 1901, when Mr. H. Hammond Smith visited Messrs. Bostock's works, he found tins of these syrups to the extent of 14 tons on the premises. Samples tested for the Commission by Dr. McGowan showed approximately one grain of arsenic to the pound of table syrup. Following on the representations mentioned above, all these tins of syrup were burnt by order of the liquidators.

Extent, Distribution, and Fatality of the 1900 Epidemic.

Niven, 463–72.
Tattersall, 7, 209–12.
Hope, 890–9.
Reid, 1969–92.
Sergeant, 4128.

8. *Evidence of Witnesses.*—The Medical Officer of Health of Manchester, after inquiries of medical men practising in the city, computed that at least 2000 persons in Manchester had suffered by the epidemic. Dr. Tattersall by similar enquiries reckoned about 1000 cases in the Borough of Salford. The Medical Officer of Health of Liverpool informed us of at least 100 cases treated in public institutions which were undoubtedly arsenical poisoning; he was, however, unable to estimate the total number of persons who were attacked in Liverpool. They were certainly numerous, but probably fewer in number than in Manchester. Dr. G. Reid as a result of inquiries from Medical Officers of Health in Staffordshire learnt of over 660 cases in that county. Dr. Sergeant by similar means collected information regarding 950 cases in the administrative County of Lancaster.

9. *Information obtained by Circular Letter.*—In May, 1901, by circular letter, we invited Medical Officers of Health of all local sanitary authorities in England and Wales to furnish us with information as to recent arsenical poisoning attributed to beer. Out of a total of 1148 boroughs, urban and rural sanitary districts* making returns in answer to our communication the Medical Officer of Health had made inquiries, with negative results, in 874, including 37 County Boroughs. In other instances the return stated that no inquiry had been made.

No cases were reported from any of 36 English administrative counties or from London. Two cases were reported from Essex, four from Warwickshire, and four from Wales. Practically speaking, no breweries in these 39 counties or in London had been customers of Bostock & Co.

On the other hand, cases were reported from numerous urban and rural districts noted in Table A below, and from the County Boroughs named in Table B.

TABLE A.

Administrative Counties in which Arsenical Poisoning was reported from one or more Districts.

Administrative Counties.	Number of districts in the County in which Inquiry was made by Medical Officer of Health.	Number of districts in which Result of Inquiry was negative.	Number of districts in which cases of Arsenical Poisoning were reported.	Total Numbers of Cases where estimated.
				About or Over.
Cheshire	35	31	4	48
Cumberland	21	17	4	121
Derbyshire	27	25	2	7
Lancashire	77	52	25	†650
Monmouthshire	18	17	1	30
Nottinghamshire	11	8	3	27
Shropshire	17	16	1	32
Staffordshire	40	24	16	†355
Wiltshire	19	18	1	—
Yorkshire (W.R.)	79	71	8	196
Totals	344	279	65	1,466

* According to the census of 1901, the total number of urban and rural districts in England and Wales, including 67 County Boroughs, is 1815.

† Information obtained independently by County Medical Officers of Health shows that the total of cases in the county was much larger than this figure—see above.

TABLE B.

County Boroughs in which Cases of Arsenical Poisoning were reported.

County Boroughs.	Number of Cases of Arsenical Poisoning, where estimated: about or over.	County Boroughs.	Number of Cases of Arsenical Poisoning, where estimated: about or over.
Birkenhead	100	Oldham	8
Birmingham	4	St. Helen's	6
Blackburn	15	Salford	996
Bolton	9	Sheffield	32
Bury	16	Stockport	2
Chester	35	Walsall	4
Hanley	5	Wigan	6
Liverpool	?	Wolverhampton	7
Manchester	2,000	Total (over)	3,245

Medical Officers of Health, in giving estimates of the number of cases which occurred in their districts, have in many instances been careful to point out that there must have been others which did not come to their notice.

10. *Summary as to extent of Epidemic.*—The information obtained from the above sources shows that, if allowance is made for about 1000 cases in Liverpool, the total number of persons who suffered in consequence of the epidemic was certainly 6000, and probably the number was in fact very considerably greater.

11. *Fatal Cases.*—It is impossible to determine the fatal cases of this epidemic with any approach to accuracy. Information received from various sources, including the returns from Medical Officers of Health above referred to, shows that a total of 70 fatal cases occurred which were attributed to poisoning by arsenic in beer. In nearly all these cases arsenical poisoning was entered in the death certificate as the cause or as one of the causes of death, or was found to be a cause of death as the result of a Coroner's inquest.

It is evident, however, that deaths thus certified do not represent the total number of cases in which death resulted from, or was accelerated by, poisoning due to arsenic in beer. Deaths occurring before the discovery of the cause of the outbreak were frequently certified as due to "chronic alcoholism," and "cirrhosis of the liver," and in some cases were attributed to Addison's disease and locomotor ataxy. Other deaths were recorded as due to "alcoholic," "peripheral," or "multiple" neuritis.

Tattersall, 48–55.
Niven, 491.
Sergeant 4128, 4233–4.
Raw, 6306–7.
Reynolds, 8421–31.

It might be expected that an approximate estimate of the share of arsenical poisoning in producing deaths recorded as due to such causes as cirrhosis of the liver, chronic alcoholism, and neuritis in the localities principally affected could be obtained by comparing the mortality figures for 1900 with those of previous years. Dr. Tatham has furnished us with data regarding deaths from these causes which were specially extracted at the Registrar General's Office for the year 1900. Unfortunately, however, the Registrar General's customary classification of causes of death does not separately distinguish deaths from the diseases in question, and we have no data available in respect of years antecedent to 1900 with which to make the comparison desired.

Tatham, 2537–50.

Appx. 17, p. 196.

12. *Effect of the Epidemic on the Birth Rate.*—Dr. Niven has put before us statistics regarding an unusual and considerable fall in the birth rate for the year 1901, in the boroughs of Manchester, Salford, and Liverpool, which he is inclined to regard as the result of the epidemic of the previous year in view of a number of data which he supplies. The decrease in the birth rate in each borough was strongly marked during the third quarter of 1901, and was manifested, though to a less degree, in the second and fourth quarters; the period during which a large portion of the beer in these cities was seriously contaminated being some six or eight months before November, 1900, and the greatest amount of sickness due to arsenical beer having occurred in the fourth quarter of 1900. On comparison with London and with thirteen large towns which were only slightly, if at all, affected by the 1900 epidemic, Dr. Niven found that in no instance had there been any fall of birth rate in the third quarter of 1901 at all comparable in extent to that which occurred in Manchester, Salford and Liverpool. Moreover, when the rates in the several sub-areas of Manchester came to be examined, the fall in birth rate in the third quarter of 1901 was seen to be greater in particular parts of Manchester which were known to have been most seriously affected by the epidemic of the year before.

Symptoms of Poisoning due to Arsenic in Beer during the Epidemic of 1900.

13. It is obvious that during the epidemic the conditions under which different individuals came to suffer in consequence of drinking arsenical beer must have varied largely. There were great differences in individual cases as regards the quantity of arsenic in the beer consumed, the amount of beer taken, and the duration of the period over which arsenical beer was drunk; and there were also further differences between individual beer drinkers—*e.g.*, as to age, sex, health, conditions of nutrition, and habits as regards alcohol—which determined the extent of their susceptibility to arsenical poisoning at the time when they began to take beer containing arsenic.

Vol. I, Index, "Symptoms."

Corresponding to these and other differences, the disease produced by the arsenical beer during the epidemic varied greatly in its manifestations. In our minutes of evidence are brought together a series of detailed descriptions by careful medical observers of individual cases of poisoning, of different clinical types which they have distinguished, of particular symptoms met with at different stages of the malady produced, and of pathological changes observed *post mortem*. The descriptions given by these observers—notably by Drs. Reynolds, Stevenson, Luff, Dixon Mann, Kelynack, Raw, and Sir L. Brunton—deserve careful attention, and form valuable material for reference and comparison in future cases or future outbreaks, where the possibility of arsenical poisoning calls for consideration.

14. These accounts show on the one hand, that there occurred throughout the epidemic (and particularly it would seem towards its termination, when people had been drinking arsenical beer for many weeks or months and so had taken considerable quantities of the poison), an abundance of cases in which, once the possibility of arsenic was entertained, there was comparatively little difficulty in deciding, on clinical grounds, that the illness was consistent with arsenical poisoning. Such cases presented symptoms corresponding to those described as characteristic of subacute poisoning by arsenic, or which are met with in the poisoning which occasionally results from long-continued doses of arsenic taken medicinally. They showed, for example, inflammation of various mucous surfaces—leading to coryza, huskiness, lacrymation, and the like; gastro-intestinal disturbance and diarrhœa; peripheral neuritis affecting sensory and motor nerves, and in some cases associated with herpes or with well-marked erythromelalgia; keratosis; or recent pigmentation corresponding to that which not infrequently occurs in persons taking arsenic for long periods.

15. On the other hand, symptoms of the above kind were often slight or absent altogether, and one of the most instructive points in connection with the outbreak is the occurrence of cases in which the symptoms, if taken by themselves and apart from the epidemic, would not have appeared to be readily or sufficiently explained by the suggestion that arsenic was the cause of illness. Thus in several comparatively mild cases, the sufferers complained merely of burning hands and feet, or they showed a variety of skin eruptions which are observed in many conditions which have nothing to do with arsenical poisoning. In other cases, again, the main symptoms were those resulting from dilated heart; and special difficulty arose in cases showing evidence of well-marked peripheral neuritis not associated with symptoms pointing clearly to arsenic, and which appeared practically identical with "alcoholic neuritis," a disease previously considered to be the result, alike in drinkers of beer and spirits, of the toxic action of alcohol on nerve tissue.

Vol. I, Index. "Heart." "Alcoholic Neuritis."

POISONING FROM ARSENIC IN BEER, APART FROM THE EPIDEMIC OF 1900.

16. *Prevalence of Alcoholic Neuritis in certain parts of England before 1900, and its relation to Arsenic.*—It is evident that the circumstance that medical men in the localities affected by the epidemic were in most instances familiar with the disease "alcoholic neuritis" was largely responsible for the delay which occurred in recognising the nature of the outbreak and in referring it to arsenic. When they found that a considerable number of cases of peripheral neuritis were coming under their observation in 1900, the matter did not present itself to them in the same striking aspect as it would have done had they been dealing with a form of disease which was new in their experience. Medical witnesses dealing with prevalence of alcoholic neuritis in Manchester and Liverpool before 1900 (and, therefore, before Messrs. Bostock & Co. employed highly arsenical acid in the preparation of their brewing sugars), have laid much stress on the relatively frequent occurrence of this disease in these cities when compared with London, with Scotland, or with large centres of population in the South of England, and on review of the evidence which we have received, we think there can be no doubt of the fact. The material which we have obtained does not suffice, however, to admit of its expression statistically. Alcoholic neuritis, unlike infectious fevers, is not a notifiable disease; the mortality statistics of the Registrar General do not discriminate deaths due to alcoholic neuritis, as we have said; a large number of cases find their way to Poor Law Infirmaries where little record has been kept of them, and in the case of Hospitals or Infirmaries where data are available, many opportunities of fallacy arise when the experience of one institution is compared with that of another. Such comparative data as we have obtained however are consistent with the medical evidence to which we have referred. Evidence in the same direction has been furnished us by members of the medical staff of several large provincial hospitals in southern and eastern counties, who in each instance have written that in their experience of private and hospital practice alcoholic neuritis is a disease of extremely rare occurrence.

Vol. I, Index, "Alcoholic Neuritis."

17. The "alcoholic neuritis" thus formerly prevalent in Manchester and Liverpool had for some years before 1900 been recognised locally as a disease affecting beer drinkers far more than spirit drinkers, and the relation of this circumstance to arsenic requires to be considered.

Tattersall, 72-3. Reynolds, 344. Kelynack, 3573. Raw, 6356.

18. There can be no doubt that a considerable proportion of beer brewed in some parts of the country before 1900 contained noteworthy quantities of arsenic, mainly derived from malt and from brewing sugars. It is also evident that before 1900 the degree to which beer has been liable to receive arsenic from malt must have varied greatly in different parts of England. Malt has been shown to have been subject to arsenical contamination in much greater degree when the fuel used on

Vol. I, Index "Beer, Arsenic in."

cf. paras. 87, 93, 97, below.

the kiln has been gas coke than when other forms of malting fuel (oven coke or anthracite) have been employed, and it may safely be concluded that the quantity of arsenic introduced into beer through malt has been in the past greater where brewers have made beer from malt dried over gas coke. In maltings in the Southern Counties of England the use of gas coke has never been common, but in certain parts of the North and Midlands of England gas coke was habitually used before 1901, and in the cities we are now considering, Manchester and Liverpool, gas coke was constantly employed at the maltings supplying various breweries. Our evidence shows that Manchester and Liverpool brewers habitually obtained large quantities of malt from Yorkshire maltings where local gas coke was used, and that in 1900 certain of these malts were found to contain considerable quantities of arsenic. Brewers in Manchester and elsewhere, who on the discovery of the cause of the epidemic took steps to secure that their brewing sugars were free from arsenic,—or who for a time abandoned the use of brewing sugars altogether—found nevertheless that they could not produce beer which could be regarded as practically free from arsenic until they had discontinued the use of malt which had been dried over this fuel. It may be concluded, therefore, that the fact of greater prevalence of alcoholic neuritis among beer drinkers in Manchester and Liverpool before 1900 when compared, for example, with London and places in the Southern Counties, is consistent with the explanation that (whatever may have been the case with regard to brewing sugars) the degree to which beer was likely to become contaminated by arsenic was greater in these two cities owing to the larger proportion of arsenic contained in much of the malt there used.

Vol. I. Index, "Malt," "Fuels."

Salamon, 1343–6.
Tomson, 3094–9.
Miller, 3407–13.
Estcourt, 3981–7.
C. Brown, 6710.

Diminution in "Alcoholic Neuritis" and "Alcoholic Heart" in Manchester since the epidemic of 1900.

Vol. I. Index, "Brewers."

19. Very stringent precautions were taken by brewers in Manchester after the discovery of the cause of the epidemic to secure that the various ingredients of their beer were satisfactory as regards arsenic, and it is certain that beer consumed in Manchester during and since 1901 has been far better in respect of arsenic than was the case before the highly-contaminated Bostock brewing sugars came on the market in 1900. If, therefore, arsenic in beer had been in any measure responsible for "alcoholic neuritis" in Manchester before 1900 it was to be expected that the prevalence of this disease would be found to show a marked diminution in 1901 and 1902. The later evidence of Dr. Reynolds, who put before us his experience at Crumpsall Infirmary and at the Manchester Royal Infirmary, and also the opinions of other physicians practising in Manchester, leaves no doubt that this in fact has been the case. Save for persons who had suffered during the epidemic, he had been unable to ascertain the existence of any alcoholic neuritis among beer drinkers in 1901. His evidence is instructive also by showing that in Manchester there has occurred, in parallel fashion, a marked diminution in certain other disease conditions which before the 1900 epidemic had not been associated with arsenic in beer. He drew particular attention to a morbid condition termed "alcoholic heart" which had long been recognised in Manchester as occurring among beer drinkers. Patients presenting symptoms of this characteristic affection of the heart (with or without other marked symptoms of illness) had been specially numerous during the 1900 epidemic; after the epidemic these cases practically ceased altogether.

Reynolds, 8227–9, 8322–58, 8402.

Arsenical Poisoning in Halifax in 1902.

20. In January, 1902, the attention of the Commission was directed to statements that cases of illness attributed to arsenical beer had occurred among patients recently admitted to the Poor Law Infirmary at Halifax. Local inquiry was made on behalf of the Commission by Mr. H. Hammond Smith, who presented a detailed report giving the results of his observations, and the information which he had collected from

Reynolds, 8403–42.
H. Smith, 8628–847.
Thorpe, 8847.
Thompson, 8848–9089.
Neech, 9090–265.

medical men, analysts, local officials, brewers, maltsters, and others. This report was considered at our meeting on March 21st, and on April 11th and 18th we heard various witnesses on the subject, including the Medical Officer of Health of Halifax and the brewers principally concerned, to whom copies of Mr. Hammond Smith's report had previously been sent. We also received an account of a series of analyses of Halifax beer and brewing materials which were made at the Government Laboratory in consequence of the outbreak.

Buckley, 9366–419
Worsick, 9240 99.
Fairley, 9923.

21. The principal facts were as follows: In January and February, 1902, eight cases came under notice in Halifax Poor Law Infirmary, and some five or six other cases were heard of in the borough, in which poisoning by arsenic in beer was suspected. The majority of these cases, including three which proved fatal, presented symptoms pointing unmistakably to arsenical poisoning; the remainder were in all probability to be referred to the same cause.

All the persons attacked were beer drinkers, and in most instances heavy beer drinkers. There was no reason to suspect that they had received arsenic otherwise than through beer, while there was strong evidence that the beer they had consumed had been arsenical. Samples of beer taken in January, 1902, from public-houses frequented by certain of these cases were found to contain between $\frac{1}{40}$th and $\frac{1}{16}$th of a grain of arsenious oxide per gallon. Inquiry was made as to the origin of the various beers which had come under suspicion. They were traced back to particular breweries, and the source of the materials used in the brews which were specially implicated was ascertained. In some of these brews glucose or "invert" sugar had been used, but these had been supplied by different manufacturers, and the evidence gave no indication that the beers in question had obtained their arsenic by way of brewing sugars. None of the breweries concerned had been customers of Bostock & Co. in 1900. In two beers containing respectively $\frac{1}{16}$th of a grain and $\frac{1}{35}$th of a grain of arsenic per gallon no brewing sugar had been used.

H. Smith, p. 17.
Thorpe, pp. 30-31.
Fairley, 9744.

22. On the other hand, the facts pointed strongly to the conclusion that the implicated beers had been contaminated by arsenic derived from malt used in their preparation. In nearly every instance there was evidence that the malt concerned had been dried over local gas coke, and that the brewer, before using it, had taken no precautions to ascertain its condition as regards arsenic. In several cases the malt which was actually in use at the brewery at the date of inquiry had been recently made, in the 1901–2 malting season, and had been dried over anthracite, and specimens of such malt which were available for chemical examination were not found to be highly contaminated by arsenic. But on closer inquiry at these breweries it was found that the malt which had been used in the implicated brews was of a different character, as it had been dried in the previous malting season, 1900–1, and over gas coke; and at some maltings in the Halifax neighbourhood gas coke was still used in 1902. One large brewery, making its own malt, was using as much as 85 per cent. of gas coke for malt drying; at another it was found that gas coke was used when a sufficient supply of anthracite was not available.

Thompson, 8933-6.
H. Smith, 8764.

23. Certain samples of malt which appeared to correspond to those which had been used in the beers under inquiry showed amounts of arsenic such as $\frac{1}{60}$th of a grain per lb. In one instance, that of a "publican-brewery" called the "Cross Keys," it was shown that in the implicated beer the brewer had used malt, in the proportion of 2 lbs. of malt to the gallon of beer, which had been purchased from Mr. Firth, a maltster, without guarantee or analysis as to arsenic. A sample of this beer taken in January, 1902, was found to contain $\frac{1}{7}$th of a grain of arsenic to the gallon. Mr. Firth had made the malt in question in the season of 1900–1901; on the single occasion on which he had sent a sample of malt made during that season to be examined for arsenic the analyst had reported as much as $\frac{1}{30}$th of a grain of arsenic to the lb.

in it. It also appeared that the malt ultimately supplied by Mr Firth to the "Cross Keys" had been rejected by a brewer in Lancashire on account of the arsenic it contained.*

24. Looking to all the evidence received in respect of the Halifax outbreak, and to the accumulated facts which show the extent of arsenical contamination to which malt is liable when prepared without adequate precautions to exclude arsenic (particularly when dried over gas coke as was the case here), we are satisfied that the arsenical poisoning in Halifax was attributable to beer contaminated by arsenical malt used in its preparation.

25. The fact that in an important borough such as Halifax, within twelve months of the epidemic of 1900, the steps taken by the brewers and by the public authorities alike proved to be insufficient to safeguard the public against beer which was dangerously contaminated by arsenic, has an important bearing on our inquiry, and we refer to it later on in this report. Here we would draw attention to the evidence it has afforded that poisoning by arsenic in beer even now may easily pass undetected, notwithstanding that a number of cases may be occurring in the same place at about the same time. The nature of the cases in the Poor Law Infirmary would very likely not have been established but for the fact that the resident Medical Officer, Dr. J. F. Hodgson † had experience of arsenical beer poisoning in Manchester in 1900. The Medical Officer of Health had no knowledge that there were cases of suspected arsenical poisoning in the Poor Law Infirmary until inquests were held, and thus it was a mere accident which led to his making special inquiry of medical practitioners in the Borough, with the result of ascertaining that cases had occurred outside the Infirmary.

Paras 154-6, below.

Alcoholic Neuritis apart from Arsenical Poisoning.

26. The fact of this small outbreak at Halifax strengthens the opinion which we have above expressed, that much of the alcoholic neuritis occurring among beer drinkers before 1900, and particularly in localities such as Manchester, was attributable to arsenic in beer. Clinically, almost all the Halifax cases were characterised by peripheral neuritis, which, taken by itself, was hardly to be distinguished from "alcoholic neuritis." Moreover, the Halifax beers associated with the outbreak must have been typical in respect of arsenic of a large class of beers prepared before the 1900 epidemic from arsenical malt.

27. In our view it is important that the question of arsenic should be fully considered in all cases of peripheral neuritis attributed to beer drinking. To what extent beer free from arsenic is capable of producing neuritis among heavy drinkers the data at our disposal do not suffice to permit an opinion to be given. We are unable to accept the thesis of some witnesses that there is, practically speaking, no "alcoholic neuritis" apart from arsenic. Inquiries which we have made as to the experience of London and provincial hospitals show that cases of alcoholic neuritis are met with from time to time in which the alcoholic liquor consumed has been exclusively spirits. All the evidence adduced is to the effect that spirits are not liable to contain arsenic.

Kelynack, 3484.
Reynolds, 8338.

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* A copy of Mr. Hammond Smith's Report was sent in March, 1902, to Mr. Firth, who was then offered an opportunity to give evidence to the Commission. Mr. Firth however, wrote that he was prevented by personal circumstances from attending to give evidence.

† At the Coroner's inquests which were held, the brewers concerned used various means to obtain a verdict that the cases were not due to arsenical poisoning and to discredit Dr. Hodgson's statements. They secured some support from Mr. J. F. Woodyatt, the visiting Medical Officer of the Infirmary, who threw doubt on the correctness of the diagnosis which had been made in one or two of the cases in question. After hearing evidence from Mr. Woodyatt, however, we are unable to attach importance to the points which he raised.

H. Smith, 8838-43.

H. Smith, p. 16; 8635
Woodyatt, 9491-651.
Neech, 9146-70.

As regards arsenical beer, it may be conjectured—and this has been the opinion of many of the medical witnesses whom we have examined on the subject—that when small doses of arsenic are taken for a long time together with considerable quantities of alcohol, the arsenical poisoning liable to result will be manifested more frequently and more conspicuously by peripheral neuritis than if the arsenic had been taken without the alcohol. In this connection it is interesting to note an account which we have received of an epidemic of arsenical poisoning at Hyères in 1887, in which the sufferers presented symptoms very closely parallel to those observed during the epidemic of 1900. At Hyères numerous cases of paralysis occurred, and it was an alcoholic drink, wine, which was contaminated by arsenic and which caused the outbreak.

Luff, 2859, 2938.
Kelynack, 3564.
Brunton, 5944.
Raw, 6304-12.
Delépine, Appx. 16.

Appx. 14, p. 339.

Form in which Arsenic is present in Arsenical Beer.

28. The suggestion has been made that certain clinical manifestations of poisoning from arsenic in beer may have resulted from the presence in the beer of some compound of arsenic with organic matter possessing toxic action differing from arsenious oxide: for example, causing less irritation of mucous surfaces, or a greater degree of neuritis. In the opinion of several chemical witnesses it is not unlikely that arsenic may exist in beer in combination with organic matter (para. 54, below). But we have received no evidence that any such compound has actually been separated, or that its chemical and toxicological properties have been ascertained. In the absence of knowledge on these points, we see no reason to assume from merely clinical data that poisoning by arsenious oxide in beer would of itself have been insufficient to explain the morbid conditions observed. It should be observed in this connection that several chemists have sought for evidence of the presence of derivatives of cacodyl, or of substances akin to cacodyl in which arsenic exists in comparatively stable combination with alcohol radicles, both in arsenical beer such as that prepared with Bostock brewing sugars, and in beer and wort to which arsenious oxide was added under experimental laboratory conditions. The results of these investigations have been negative. Cacodylates, it should be noted, in proportion to the arsenium they contain, are relatively much less toxic than is arsenious oxide.

Vol. I. Index, "Organic Matter."
Vol. II. Index, "Organic Matter."

Salamon, 1374, 1518.
Delépine, 5232-4, *10,331-5.*
Hooper, 7806-8.
Helmer, 8044.

Individual Susceptibility to Arsenic.

29. Great differences exist between individuals in their susceptibility to poisoning by arsenic, and this fact is abundantly illustrated in our evidence. Instances of tolerance of large medicinal doses (such as even 30 minims of *liquor arsenicalis*, or $\frac{3}{10}$ths grain of arsenic, two or three times a day) have, for example, been reported to us by Dr. Stevenson and Professor Delépine; and the well-known accounts of the tolerance of arsenic by Styrian peasants have been frequently referred to. The epidemic of 1900 itself afforded many instances of tolerance; indeed, one of the most striking facts of the epidemic was that large numbers of people must have been drinking beer, much of which was contaminated by arsenic to a high degree, in considerable quantities over several months without any apparent bad result. Another illustration of tolerance of arsenic appears to be furnished by the comparative rarity of severe poisoning among workmen engaged in recovering arsenic in arsenic-roasting works in Cornwall, and in the manufacture of arsenical pigments and sheep dips. Other factors beside personal insusceptibility have to be taken into account in these cases, particularly the precautions which are adopted to prevent inhalation of dust, and the insolubility of certain of the arsenical compounds which are liable to be swallowed; but when allowance is made for these, it is still remarkable that the poisoning reported among arsenic workers appears in most instances to be confined to catarrhal affections of the throat and upper air passages; peripheral neuritis and other symptoms of chronic arsenical poisoning such as were met with in the 1900 epidemic being almost entirely absent.

Stevenson, 2452.
Delépine, 5307.

Roscoe, Memoirs Lit. Phil. Soc. Manchester, 1860.

Legge, 11,733-834.

Tattersall, 19.
Stevenson, 2463.
Mann, 3798.
Neech, 9264-5.

30. On the other hand, numerous instances of exceptional susceptibility to poisoning by arsenic have been brought to our notice, including, for example, such instances as symptoms of poisoning following the medicinal administration spread over several days of a total quantity of arsenic no more than $\frac{1}{8}$th of a grain, or, in another case, following a single dose of $\frac{1}{50}$th of a grain. Paralysis has been reported to have followed taking a daily dose of 10 minims of *liquor arsenicalis* ($\frac{1}{10}$th grain of arsenic) for three weeks. There can be no doubt that many of the persons who suffered during the epidemic—especially severe cases in which no more than one or two pints of beer daily had been consumed—were individuals specially susceptible to arsenical poisoning.

Vol. I., Index, "Epidemic."

31. It has been suggested that during the 1900 epidemic women showed a greater susceptibility to arsenical poisoning than men. Although we have received particulars of the number of men and women respectively who were admitted to several hospitals and infirmaries suffering from arsenical poisoning, we have not data sufficient to show whether as a matter of fact in any large population affected by the epidemic a greater total number of cases occurred among women. Still less do the facts available enable a contrast to be drawn between the incidence of poisoning in men and women when account is taken of the relative proportion of beer drinkers in each sex, and of the quantity of beer habitually taken by men and women respectively. There can, however, be no doubt of the fact that as a whole women in 1900 suffered more severe attacks than men, and an altogether disproportionate number of fatal cases occurred among women. One explanation is that whereas the men often resorted to a number of different public-houses, and so got beer from different breweries which was sometimes contaminated by Bostock sugars and sometimes not, the women drank beer at home which they habitually obtained from the same public-house, so that often all their beer was arsenical. Apart from this, it has been suggested as a reason that women eliminate arsenic less rapidly owing to their taking comparatively less exercise, and that their apparently greater susceptibility may be due to their taking less food than men.

Appx. 16, p. 183.
Delépine, 10,387-423.

32. Professor Delépine in 1902 communicated to us the result of a long and interesting series of observations in his laboratory on the effect of administration to rats of known and varying quantities of arsenic, both in watery solution and in beer, along with suitable control experiments. These observations deserve study in relation to the question of individual susceptibility. Prof. Delépine found that minute quantities of arsenic could be administered over comparatively long periods before detrimental results appeared, so long as the experimental animal was taking an abundance of food: whereas in rats under identical conditions but on comparatively restricted diet the deleterious effects of the arsenic were much sooner apparent. In the case of rats taking arsenic he found that beer, rather than being detrimental, appeared to increase the resistance of the rats by improving nutrition.

Accumulation of Arsenic in Human Tissues, and Ways in which Arsenic is Eliminated.

Stevenson, 2219-60.
Mann, 3782-3.
Delépine, 5314.

33. In a few of the Manchester cases which terminated fatally, certain of the viscera were tested for arsenic by Dr. Stevenson and by Dr. Dixon Mann. Small, though weighable, quantities of arsenic (·011 grain in 13½ ounces) were recovered from the viscera examined (liver, spleen, and portions of intestine) in one instance, where death had taken place six days after the patient ceased to take arsenical beer; in three other cases, where death had taken place respectively 14, 32, and 52 days after beer ceased to be taken, arsenic was detected in the viscera examined, but was present in amounts too small to be weighed. In one case—a woman presenting well-marked symptoms of arsenical poisoning during life, who died 23 days after ceasing to take beer—no arsenic at all was detected in the viscera tested.

So far as the particular organs examined are concerned, these results accord with the generally-accepted view that arsenic is a poison which, as a rule, is eliminated comparatively rapidly from the body—by contrast, for example, with such a "cumulative" poison as lead, which, when taken in small doses over long periods, becomes stored in the liver and elsewhere.

34. On the other hand the clinical data obtained during the epidemic show that arsenic can only be termed a "non-cumulative" poison in a restricted and comparative sense. It is necessary for their explanation to assume that when small quantities of arsenic are taken over long periods, accumulation does take place in certain tissues. Many of the cases admitted to hospital in 1900 continued to show increasing signs of poisoning for weeks after beer had been discontinued. In some cases there was a recurrence of symptoms of arsenical poisoning after the patient had almost recovered, no beer or arsenic having been taken for many weeks. An examination of the urine in several cases showed that arsenic could be detected three weeks or more after the patient had been admitted to hospital, while in an exceptional instance Dr. Dixon Mann found arsenic in the urine after fifty-nine days.

Raw, 6327-33.

Kelynack, 3571.
Mann, 3731-3.
Raw, 6336-40.
Reynolds, 8450-3.

35. Important observations have been made in several cases regarding the numerous ways in which arsenic may be eliminated from the body. Arsenic was detected in sweat, in the epidermic scales which are freely shed in the condition known as keratosis, in nails, and in hair. It appears probable, as Dr. Dixon Mann has pointed out, that epidermic tissues which principally consist of keratin, have a special affinity for arsenic, and that the effect of arsenic upon nerve tissue may be related to the fact that nerve sheaths consist largely of keratin.

Vol. I., Index, "Elimination."
Reynolds, 8296-314
Appx. 16, p. 188.

Mann, 3737.

Elimination of Arsenic by the Hair.

36. The fact of arsenic being excreted by hair appeared to us of special interest. If it were established that persons taking comparatively small quantities of arsenic habitually excrete the poison in their hair to an extent which is readily appreciable by chemical tests, examination of hair might be of much value in cases where it is important to obtain indications of the past history of a patient in regard of arsenic. Accordingly we took steps to obtain, with the aid of the Medical Registrars of certain London Hospitals, and the Medical Superintendents of certain London Infirmaries, samples of hair from patients who had taken arsenic in known amounts over known periods of time, together with suitable controls, and we engaged the services of Mr. R. F. Wood Smith to analyse these hair samples for arsenic.

Mann, 3737.
Appx. 32, p. 345.

37. The results of these experiments, reported in Appendix No. 32, are instructive. Out of a total of 41 control cases, principally hospital and infirmary in-patients, both males and females, who had been taking no arsenic medicinally, the hair of 38 was either free from arsenic according to the tests employed, or showed no more than $\frac{1}{150}$th grain of arsenic per pound of hair (0·96 parts per million). Only three showed larger amounts (viz., $\frac{1}{100}$th, $\frac{1}{50}$th, and $\frac{1}{25}$th grain per pound, respectively). Samples of hair were obtained from the same cases after they had taken arsenic medicinally. Male patients who had been taking three minims of *liquor arsenicalis* three times a day (about $\frac{1}{10}$th grain of arsenic daily), at the end of two months showed amounts of arsenic varying from $\frac{1}{20}$th grain to $\frac{1}{5}$th grain per pound in hair which had grown during the interval, with the exception of one case which showed $\frac{1}{50}$th grain per pound. Male patients taking smaller amounts of arsenic medicinally—three minims or four and a-half minims of *liquor arsenicalis* ($\frac{1}{33}$rd and $\frac{1}{22}$nd grain of arsenic) daily—for two months, also showed notable amounts of arsenic, varying from $\frac{1}{80}$th to $\frac{1}{10}$th grain per pound in their recently-grown hair.

In the case of female patients under like conditions, considerable difficulty arose in obtaining samples which represented the hair

which had grown during the period of arsenic taking, but the results, though less uniform than in the male cases, were similar in character.

The results of testing hair of cases, both male and female, in which arsenic had been taken for less than five weeks, were much more irregular, owing, no doubt, to the fact that the sample examined usually comprised an uncertain proportion of hair which had grown before the administration of arsenic had begun.

Hair was also examined in a considerable number of cases in which no "controls" were available, arsenic having already been taken in varying amounts for considerable periods of time at the date of collection of the hair specimen. Nearly always, in these cases, when portions of the hair were examined which approximately corresponded to the period during which arsenic had been taken, a relatively large amount of arsenic was detected. In some instances, arsenic was detected in recently-grown hair several weeks after the drug had ceased to be taken.

Importance of Exclusion of Small Quantities of Arsenic from Food.

38. On review of all the evidence on the subject, we are of opinion that the exclusion of small quantities of arsenic from food and drink is of greater importance than might at first sight be supposed, and calls for more attention than it has hitherto received. The question has often arisen, with reference to particular foods liable to contain a relatively minute quantity of arsenic, whether such a quantity may not be regarded as unimportant and altogether negligible, and the Commission have, as it were, been challenged to say that it can do no harm. But allowance has to be made for the possibility of other small quantities of arsenic being received at the same time from more than one source of food and drink, and susceptible people have to be considered. And as regards diagnosis, it should be observed that notwithstanding the greater attention which has been given to the subject of chronic arsenical poisoning in consequence of the recent epidemic, it is to be expected that the true nature of milder forms of poisoning occurring in isolated instances will often fail to be recognised. And it is obvious that even if arsenical poisoning were suspected in such cases there is very little likelihood of the origin of the arsenic being satisfactorily traced.

39. Clinically, moreover, the effect of quite small quantities of arsenic administered over long periods along with food cannot be said to have been fully studied; evidence of marked toxicity may be absent, but yet the arsenic may have unrecognised effects upon nutrition.

Appx. 16, p. 190.

40. In the experiments to which we have above referred, Professor Delépine found that the rat, an animal which is less susceptible, weight for weight, than man, to a fatal dose of arsenic, appeared to be injured by the continuous ingestion of liquid containing as little arsenic even as $\frac{1}{140}$th grain per gallon. As the result of his experimental investigations, and of a general study of the subject, he was led to conclude that continuous daily ingestion of $\frac{1}{100}$th grain of arsenic along with beer or food may be prejudicial to the human subject.

Delépine, 10,400.

41. Looking to these various considerations, we adhere to the view expressed in our First Report, that it would be unwise to express an opinion that any quantity of arsenic, however small, is to be regarded as admissible in any articles of food, and we think it should be the aim of the food manufacturer to exclude arsenic altogether from his products.

PART II.

THE SUGGESTED RELATION BETWEEN THE DISEASE "BERI-BERI" AND ARSENICAL POISONING.

42. Dr. Ronald Ross and other medical observers have laid stress upon the similarity between the symptoms of poisoning observed in the 1900 epidemic and those of beri-beri, a disease mainly characterised by peripheral neuritis, which is met with in certain tropical countries. Although the etiology of beri-beri is not at present understood, certain facts regarding its occurrence indicate that the disease may be due to the presence in particular articles of diet of a poison which has a toxic action on nerve tissue, and it has been suggested that beri-beri may prove to be due to contamination of food by arsenic.

Vol. I., Index, "Beri-beri.
Vol. II., do. do.

43. A few data tending to support this suggestion were supplied to us by Dr. Ross and Dr. Reynolds in the earlier stages of our inquiry. More recently, however, investigations into the question of arsenic have been made in countries where beri-beri is prevalent, particularly in the Federated Malay States, and, although we are not in a position to state how far the results of these inquiries may be accepted as conclusive, we understand that they have not established the existence of any relation between tropical beri-beri and arsenical poisoning.

44. Cases diagnosed as "beri-beri," and considered to be identical with the disease met with in tropical countries, occur from time to time among sailors arriving at English ports. Those attacked are usually either Indians or Lascars on steamships coming from Eastern ports where beri-beri is common, or Scandinavians* on sailing ships arriving, at the end of long voyages, from many parts of the world. We decided to utilise as far as possible the limited opportunities of inquiry which were thus available, and accordingly in September 1901 we invited the Medical Officers of Health of certain English Port Sanitary Districts to supply us with information regarding cases of ship-borne "beri-beri" which came to their notice, and to collect and forward samples of foods from such vessels, which we arranged to have tested for arsenic in Dr. McGowan's laboratory. With the assistance of Dr. Herbert Williams (Port of London), Dr. C. Bullmore (Port of Falmouth) and other Port Medical Officers of Health, we obtained particulars of 21 vessels arriving between September 1901 and October 1902, on which beri-beri had occurred during the voyage, and various food samples from 14 of these vessels were examined for arsenic. A detailed account of the information thus obtained is given in Appendix No. 31 to our Minutes. In a few instances the results gave some ground for inference that the beri-beri cases inquired into had lately been taking arsenic along with their food. Thus the hair of one or two of the patients contained noteworthy amounts of arsenic, while small quantities of arsenic were found in several samples of dried fish—an important article in the diet of sailors on Scandinavian sailing ships. But when such clinical, etiological, and chemical data as we have been able to collect are considered as a whole, they cannot be said to support the view that cases of "beri-beri" met with on ships arriving at home ports are essentially attributable to poisoning by arsenic.

Appx. 31, p. 334.

* Professor V. Uchermann has kindly sent us the report of a Committee lately appointed by the Norwegian Government to inquire into the subject of beri-beri (Kristiania, 1902). This report gives further evidence of present difficulties in determining the cause of the "beri-beri" which occurs among Scandinavian sailors; it affords little information on the question of the possible relation between the disease and arsenic.

PART III.

TESTS FOR ARSENIC IN FOOD AND SUBSTANCES USED IN THE PREPARATION OR MANUFACTURE OF FOOD.

45. The evidence which had been received at the date of our First Report showed that there existed then a very considerable diversity of opinion as to the relative value of different methods of estimating small quantities of arsenic in beer and in other foods. Many instances were reported to us in which discordant results had been obtained when identical samples were examined by different analysts and by different methods; and brewers, who were the food manufacturers principally concerned, made complaint of the position of uncertainty and difficulty in which they were consequently placed.

Vol. I., Index, "Tests."
Stevenson, 2475.
Salamon, 1318-29, 1524-8.
Scudder, 4268-330.
C. Brown, 6759, 6790-870.
Hooper, 7777-906.
Hehner, 7907-8057.
Vol. II., Index "Tests."
Thomson, 9654-815.
Fairley, 9878-87.
Salamon, 9969, 10,036.
Hehner, 10,094-225.
Chapman, 10,226-372.
Ling, 10,451-708.
Thorpe, 11,654-737.
Allen, 11,974-80.
McGowan and Finlow, Appx. 22, p. 220.

Since that date we have received reports of a large amount of work on the subject which has been undertaken by many chemists.

The substances examined with reference to tests have been numerous and varied. They comprise beer, malt, sugars, and various other foods and organic substances liable to contain arsenic; fuels; and chemical substances used in connection with food preparation.

46. We would refer to the valuable evidence received from a number of eminent chemists which appears in our Minutes and which gives details of the methods of examination which these analysts have studied and adopted, and also to a report received from Dr. G. McGowan (Appendix 22 of our Minutes) on the methods employed at his laboratory in testing various food samples for the Commission.

In addition to this evidence from individual analysts, we have received the Final Report of the Committee appointed by the Manchester Brewers' Association, dated May 11th 1901 (Appendix 19); and the Report of the Joint Committee appointed in March 1901 by the Societies of Public Analysts and Chemical Industry, with Mr. Hehner as chairman. This Committee made a careful investigation of the Marsh-Berzelius method, and presented a Report early in 1902, which was subsequently discussed at a joint meeting of the two Societies (Appendix 20).

Appx. 19, p. 201.

Appx. 20, p. 206.

As part of the action taken by the Board of Inland Revenue in pursuance of the recommendation in paragraph 34 of our First Report, a Departmental Committee was appointed in January 1902, with Professor Thorpe as chairman, to prescribe tests for arsenic in beer and brewing materials. Their Report was presented to us by Sir Henry Primrose in April of this year (Appendix 21).

Appx. 21, p. 208.

47. We are now in a position to review the information obtained from these various sources under the following heads:—Estimation of arsenic by comparison of mirrors obtained by the Marsh-Berzelius method with zinc and acid; Estimation by comparison of mirrors obtained electrolytically; Estimation by other quantitative methods.

Comparison of Mirrors obtained by the Marsh-Berzelius Method.

48. The evidence shows that it is now recognised that a satisfactory estimation of the arsenic in a given substance can be made by comparing mirrors obtained by the Marsh-Berzelius method, after the substance examined has been subjected to appropriate treatment by which any arsenic present is obtained in a solution suitable for the proper application of the test.

This method has lately been investigated in much greater detail than formerly, and certain new and important points have been

worked out. It is, for instance, now recognised as essential, not only to obtain zinc and acid which are free from traces of arsenic and to verify this freedom by control experiments, but also to see that the zinc used is "sensitive," and will permit all the arsenic in the solution to be evolved as arseniuretted hydrogen. Another matter brought out by recent investigation is that the presence in the solution of certain metals, notably iron, is liable to retard, or entirely to prevent, the evolution of arseniuretted hydrogen, and thus may seriously affect the estimation.

Thomson, 9759-4.
Fairley, 9882-7.
Hehner, 10,129.
Chapman, 10,236, 10,239
Ling, 10,646-8.
Thorpe, 11,666.
Appx. 22, p. 221.
Appx. 23, p. 227.

49. Chemists now appear to be in general agreement as to these and other sources of error which it is necessary to avoid, and as to the essentials to be regarded in estimating arsenic by this test.

50. The proceedings recommended by the various Committees and witnesses vary in many points of detail: for example, in the steps taken to obtain satisfactory zinc and acid, in the size of the generating flask, in the quantity of the reagents employed, and in the methods to be adopted to secure that the mirrors are satisfactorily deposited. We do not attempt to pronounce for or against particular modifications in the application of the Marsh-Berzelius method which are preferred by one or another analyst. We are satisfied that careful analysts who estimate arsenic by this method can obtain results sufficiently exact and comparable for practical purposes, although the details of their procedures may differ.

Were it possible to secure for the future the uniform adoption by analysts of one and the same method with the same detail in all respects, the determinations would become still more closely comparable, with obvious advantage. The work of the Committees and chemists to which we have above referred, and in particular the important recommendations of the Board of Inland Revenue Departmental Committee as to tests for arsenic in various substances used in the preparation of beer, materially advance this object, but do not lead to the conclusion that at this stage any single detailed routine can be said to be applicable to all cases without exception.

51. General experience of this test has shown that when in the preparation of "standard" mirrors the quantities of arsenic added to the apparatus differ by amounts such as ·002 milligramme, a series of mirrors can be obtained showing differences in intensity which are sufficiently distinct and constant to be utilised for comparison. If the test is applied to a solution obtained from 10 grammes of a given substance, a difference in mirrors corresponding to ·002 milligramme represents ·2 parts of arsenic per million in the substance taken, or ·0014 ($\frac{1}{720}$th) of a grain of arsenic per lb. If applied to 50 c.c. of a given liquid, a difference of ·002 milligramme in the mirror represents ·04 parts of arsenic per million in the liquid, or ·0028 ($\frac{1}{360}$th) of a grain of arsenic per gallon.

Distinctions of greater or less delicacy can of course be made (within practicable limits) by increasing or diminishing the quantity of substance taken for the purposes of the test.

52. As regards *detection* of arsenic by the Marsh-Berzelius method, the evidence shows that when various substances are taken in quantities which have been found practically convenient, the presence of arsenic will be detected when in amounts well below $\frac{1}{1000}$th grain per pound, or (in the case of a liquid) well below $\frac{1}{300}$th grain per gallon.

53. Witnesses have drawn our attention to the importance of making allowance for differences in personal judgment and for other factors which may introduce difficulty in the estimation of arsenic by comparison of the intensity of mirrors. We have inquired in several instances as to the extent to which estimations may be affected from this cause in the practice of analysts conversant with the process. A difference in reading corresponding to ·002 milligramme of arsenic too much or too little appears to be regarded as an outside limit, on

Hehner, 10,146, 10,186-205.
Chapman, 10,369-72.
Allen, 12,049-1.
Appx. 22, p. 222.

which basis the total error in an estimation where 10 grammes of material were employed would be ·0014 ($\frac{1}{720}$th) grain per lb. too high or too low, or with 50 c.c. of liquid, ·0028 ($\frac{1}{360}$th) grain per gallon too high or too low. For practical purposes this extent of possible error can seldom be of importance: in particular instances, where close approximation is desired, the difficulty can be met by making more than one estimation, or, if need be, by repeating the experiment with a solution corresponding to a larger or smaller amount of the substance.

54. Descriptions of the various forms of *preliminary treatment* which may be applied to different substances in order that all the arsenic they contain may be brought into a condition suitable for estimation by the Marsh-Berzelius method will be found in the reports and evidence to which we have above referred.

In the case of foods and other organic substances the question of destruction of organic matter has to be considered. In unground malt, from which all the arsenic can be extracted by dilute acid, and in a few other instances, the evidence shows that a satisfactory estimation can be made without destruction of organic matter. In such cases it is desirable that comparison should be made with standards prepared by the addition of known quantities of arsenious oxide to arsenic-free specimens of the material examined.

C. Brown, 6832.
Hooper, 7796.
Hehner, 8043-56.
Thomson, 9688, 9755-7.
Fairley, 9887. etc.
Hehner, 10,132-8, 10,179-85.

On the other hand, it is desirable to destroy the organic matter in instances where the organic solution in the Marsh-Berzelius apparatus is liable to cause frothing, or to cause any appreciable generation of sulphuretted hydrogen, and so may interfere with the proper working of the test. Destruction is also necessary where there is reason to suspect that some or all of the arsenic may exist in the form of an organic compound, or where it is otherwise intimately combined with organic matter; *e.g.*, in hair and animal tissues, yeast, liquorice, and coal-tar colours.

Chapman, 10,262-75.
Appx. 20, p. 207.
Appx. 21, p. 213.
Appx. 22, p. 223.
Appx. 27, p. 277.
Appx. 31, p. 351.

In the case of brewers' wort the organic matter interferes with the test to an extent which may cause small quantities of arsenic to escape observation, and hence should first be destroyed.

In the case of beer we have already stated (Part I., paragraph 28) that there is no evidence that arsenic when present in beer exists as a compound of cacodyl or its homologues. Some chemical witnesses have expressed the opinion that arsenic in beer may enter into combination in some way not understood with albuminous or other organic substances. The evidence upon this point, however, is altogether incomplete. We have evidence that comparable results have been obtained by analysts who destroyed organic matter in beer and by others who added the beer to the Marsh-Berzelius apparatus direct. On the other hand, some beers have not been found to yield all the arsenic they contain unless the organic matter is first destroyed. Mr. Hehner informed us that when using the direct method he came to the conclusion that when beer is kept for some months it may gradually lose the arsenic it contains, whereas he afterwards found that no difference in respect of arsenic could be detected between beer before and after keeping, if the organic matter was in each instance destroyed before testing.

Hehner, 10,214-25.

Several chemists who have given close attention to the subject prefer to destroy the organic matter in beer as a matter of routine before employing the Marsh-Berzelius test; and the Departmental Committee of the Board of Inland Revenue also recommend this course. It appears to us that this plan should be uniformly adopted.

55. In most substances it has been found satisfactory to destroy the organic matter, either by one or another "acid" method, or by a "basic" method, in which the substance is burnt along with lime or magnesia sufficient to retain the arsenic.

56. In the case of *fuel*, where examination is made with the object of separately estimating the arsenic which is volatilised during the

combustion of the fuel and that which remains behind in the ash, two methods of preliminary treatment have been described to us.

The first consists of burning the fuel with lime or other base in order that all the arsenic present may be retained in the residue after combustion is complete, and also of estimating the arsenic which remains when the fuel is burnt alone: the difference between the two estimations representing "volatile" arsenic. The application of this method to fuel was described to us by Mr. Ling, and its principle has been adopted by Dr. McGowan in testing for the Commission the series of samples from anthracite collieries to which reference is made below. *Ling, 10,451-76.* *Appx. 20, p. 207.* Para. 94, below.

Dr. McGowan found that in solutions obtained from the residues after combustion, the presence of iron interfered materially with estimations of arsenic by the Marsh-Berzelius test. In Appendix 23 he has given (along with Mr. R. B. Floris) a detailed account of the procedures adopted in order to eliminate this and other sources of error. *Appx. 23, p. 227.*

The second method, more recently described in the report of the Departmental Committee (Appendix 21), consists in burning the fuel in a current of oxygen, collecting the arsenic which is volatilised in an absorption apparatus containing dilute sulphuric acid; and subsequently estimating the volatile arsenic obtained in this solution, and also the arsenic left behind in the ash. For this purpose, the ash, after suitable treatment, is distilled with hydrochloric acid and the distillate is used for the Marsh-Berzelius or electrolytic test. *Appx. 21, p. 210.*

Comparison of Mirrors obtained by the Electrolytic Method.

57. The method of evolving arseniuretted hydrogen by electrolysis, without the use of zinc and acid, has recently been carefully studied by the Departmental Committee, whose Report gives an account of the apparatus designed in the Government Laboratory for the purpose, and which can be applied wherever an electric current of sufficient intensity is available. *Appx. 21, p. 208.*

The Committee have found that when the current is suitably controlled and other precautions which they describe are taken, the evolution of arseniuretted hydrogen takes place with great uniformity, and the resulting mirrors, though similar and comparable to those obtained by the zinc and acid method which they also describe, have the advantage of being more definite and thus allow for greater exactness in estimation.

58. Moreover, in examining in this way a variety of substances connected with brewing, they have found that the nature of the material associated with the arsenic exercises no inhibitory effect on the formation and evolution of arseniuretted hydrogen. They are satisfied that beer and worts may be added directly to the electrolytic apparatus without previous destruction of organic matter.

59. We understand that this method is now adopted at the Government Laboratory in preference to the Marsh-Berzelius test with the use of zinc and acid, and now that the results of the Committee's work are in the hands of chemists, wide experience of the working of the electrolytic method which they recommend may soon be looked for.

Other Quantitative Methods.

60. Our evidence shows that some chemists prefer, or at least have in the past preferred, to estimate small quantities of arsenic by other means than comparison of mirrors; *e.g.*, gravimetrically, by using a large quantity of the substance and weighing sulphide of arsenic finally obtained from it; by extracting the arsenic by means of copper gauze; by the Gutzeit test; or by the Reinsch test with subsequent examination and comparison of sublimates. *C. Brown, 6759-839. Hooper, 7777-96. Jones, 1793-803. Kirkby, 3630-85. Delepine, 4928, 5208, 10,275-80.*

61. In view, however, of the general use by analysts of methods involving comparison of mirrors, to which greater precision has been given by the work of the last few years, and of the great importance of comparability of results, it seems essential that chemists applying other methods for routine purposes to the examination of food and substances used in food preparation should be aware of the extent to which their determinations correspond with or differ from those made by comparison of mirrors.

Moulton, 9939, 9957-63.
Salamon 9969-78, 10,036-47.

62 Mr. Gordon Salamon and others have urged that, apart from quantitative estimations by comparison of mirrors, it is convenient for the brewer or maltster to use for ordinary working purposes a form of the Reinsch test, simpler in application but sufficient to show for practical purposes whether or not a material quantity of arsenic is present in beer, malt, or brewing ingredients. We fully recognise

Appx. 5, p. 323.

that the Reinsch test, as recommended by the Expert Committee appointed by the Manchester Brewers, served a most useful purpose at the time of the 1900 epidemic, when it was necessary to test rapidly a large number of beers and brewing ingredients in order to eliminate at once those which were highly contaminated by arsenic. But we are now satisfied that the use of the Reinsch test entails considerable risk of missing quantities of arsenic which, though small, are not to be regarded as negligible. It is noteworthy in this connection that at one of the breweries at Halifax which supplied arsenical beer in 1902 the beer had been systematically tested by the Reinsch method and only negative results had been reported. Having regard to the better understanding which now exists of the precautions required in using more delicate tests involving the comparison of mirrors, and to the greater ease and certainty with which those tests can now be applied, we think that the use of the Reinsch test for the purpose above indicated must be considered unnecessary, and that it may even be misleading.

PART IV.

WAYS IN WHICH FOODS ARE LIABLE TO BECOME CONTAMINATED BY ARSENIC.

63. We have received much useful evidence from witnesses as to the risks of arsenical contamination which arise in the manufacture of sundry foods and substances used in food preparation. In particular, we have obtained from chemists and manufacturers detailed accounts of processes employed in the preparation of glucose, "invert" sugar, malt, and other substances which are used in brewing; and also of sulphuric acid, in relation to arsenic.

In investigating the large subject of the liability of foods other than beer to contain arsenic, we sought in the first instance the co-operation of Public Analysts in England and Wales, and by circular letter in June 1901 we invited them to supply information as to food substances in which arsenic had been looked for or detected, or which, by reason of their method of preparation, may become contaminated by arsenic in the absence of suitable precautions. Valuable information in these directions was supplied by a large number of public analysts. Shortly afterwards we engaged the services of Mr. H. Hammond Smith, M.R.C.S., to make inquiry on our behalf from representative food manufacturers, and to visit their works. In October 1902, Mr. Hammond Smith, on completion of these inquiries, made a detailed report upon his investigations into the whole subject, which appears as Appendix 24 to our minutes.

In prosecuting his inquiries, and in preparing his report, Mr. Smith made full use of the data which had been supplied by witnesses and public analysts, and also of various suggestions as to points for inquiry which had come before the Commission in other ways. In numerous instances he obtained samples which it seemed desirable to have examined for arsenic, and we arranged that these samples should be tested in Dr. McGowan's laboratory. Dr. McGowan in Appendix 25 shows in a series of tables the results of analysis of the substances thus submitted to him and the method of testing for arsenic which he adopted in each case.

In November 1902 we took further evidence from manufacturers of food other than beer.

64. The information collected in these ways deserves the careful consideration of food manufacturers and others concerned. For the purposes of our Report, it will suffice to draw attention, first, to certain principal food ingredients and other substances which, in the absence of precautions, have been shown to involve risk of arsenical contamination of articles of food, and secondly, to certain finished foods which in consequence are liable to such contamination.

Principal Ingredients of Food, or Substances Used in Food Preparation, Which are Liable to Contain Arsenic.

Sulphuric Acid.

65. Sulphuric acid is the first and most important of the substances to be considered. Directly or indirectly this acid is used, sometimes in relatively large amount, in the preparation of a variety of foods.

The greater part of the sulphuric acid used for manufacturing and general purposes in this country is obtained by roasting pyrites ores, imported mainly from Spain and Portugal. Such ores, notably those from certain mines, contain large proportions of arsenic. Acid thus manufactured, unless subjected to a de-arsenication process, is in-

Dixon, 3415, 3461.
Davis, 6381, 6394-400.

Davis, 6399-420, 6509-16.

variably arsenical. At works where a de-arsenication process is carried out, the system of manufacture usually followed necessitates the production, in addition to the de-arsenicated acid, of an acid, derived from the Glover tower, which habitually contains a high proportion of arsenic. This, however, is not the case where the acid is prepared by synthetic processes which have been introduced in recent years.

Stevenson, 2398.
Howell, 11,229.

Tattersall, 12.
Dixon, 3439-60.
Salamon, 1264.
C. Brown, 6709-36.

The sulphuric acid ("B.O.V.") supplied in 1900 by Messrs. Nicholson & Sons to Messrs. Bostock & Co. was contaminated by arsenic to an exceptional and enormous degree. As much arsenic as 1·45 and 1·9 of arsenious oxide per cent. has been estimated in certain samples of this acid.

66. Chemical and other technical witnesses are agreed that de-arsenicating processes when thoroughly and uniformly applied at works where acid is obtained from pyrites, produce an acid which is practically free from arsenic. Such de-arsenicated acid, of the quality and specific gravity usually supplied commercially, when tested by a delicate test shows either no arsenic at all, or else only minute amounts of arsenic. Proportions of arsenic as high as from 2 to 3 parts per million (approximately $\frac{1}{70}$th to $\frac{1}{50}$th grain per pound of acid) can only occur if the de-arsenication is not properly carried out.

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67. Sulphuric acid is also manufactured from natural brimstone, from "recovered sulphur," and from the "spent oxide" of gas works. Where these materials are used the degree to which the acid is liable to become contaminated by arsenic is comparatively small, and usually such acids are not subjected to de-arsenication processes. Our evidence shows that sulphuric acids prepared in these ways can be obtained which are at least as pure as regards arsenic as de-arsenicated pyrites acid; nevertheless they must not be assumed without analysis to be free from arsenic.

68. The difference in price between arsenical sulphuric acid prepared from pyrites without purification, and sulphuric acid which is practically free from arsenic (whether de-arsenicated pyrites acid, or acid prepared in other ways) is comparatively small—*e.g.*, something less than 5*s.* on an acid sold at 2*l.* a ton—and in connection with articles of food or substances which may be used in the preparation of food this difference can seldom be of any account to the food manufacturer.

Morris, 4672.
Davis, 6407.
Appx. 24, p. 230, note.

Hydrochloric Acid.

69. Commercial hydrochloric acid, as is well known, frequently contains arsenic, which has been derived from the use of arsenical sulphuric acid in its manufacture. Where the sulphuric acid used has contained much arsenic the hydrochloric acid may be highly contaminated. Thus Mr. G. E. Davis reported 1·12 grammes of arsenious oxide per litre in a recent specimen of hydrochloric acid which had been prepared from sulphuric acid, the product of an arsenical pyrites.

Davis, 6381, 6466, 6493.

70. Hydrochloric acid free from minute quantities of arsenic appears to be less easily attainable commercially than is the case with sulphuric acid. The liability of hydrochloric acid to be arsenical is, however, relatively small in the case of acids prepared by "cylinder" or other processes in which special care is taken to employ sulphuric acid which is pure in respect of arsenic.

Appx. 20, p. 206.
Appx. 22, p. 220.
Davis, 6496.

Glucose.

71. The glucose used by brewers is usually "solid." It is manufactured on a large scale at factories in Great Britain, and a considerable quantity is also imported from America and Germany. The glucose used for confectionery, syrups, and other food purposes is generally "liquid," and is almost always imported. Solid and liquid glucose alike are liable to contain arsenic derived from sulphuric or

hydrochloric acid, which are used in varying proportions (*e.g.*, from 2 to 6 per cent.) in the "conversion" process by which the glucose is manufactured from starch. In view of the circumstances of the 1900 epidemic it is unnecessary to insist upon the high degree of arsenical contamination of glucose which may be brought about by neglect of precautions regarding the quality of the acid used. Solid glucose manufactured by Bostock & Co. in 1900 in several instances was ascertained to contain as much arsenic as 3 grains per pound, and even larger proportions of arsenic were estimated in a few specimens.

Salamon, 1466.
Garton, 60-9-64.
Francis, 7355.
Wahl, 7431-9.
Tattersall, 15.
Jones, 1768.
C. Brown, 6709.
Hooper, 7869.

72. If due attention is given to the purity of the chemical substances employed, there appears to be no difficulty in producing glucose which is free from arsenic. As stated in our first report, glucose manufacturers in general were aware of the necessity of guarding against arsenic before the 1900 epidemic, and took precautions with this object. Since then, as was to be expected, such precautions have been generally strengthened. Instances have been reported to us in which specimens of glucose, both of home and foreign manufacture, and not coming from Bostock's, have been found to contain from $\frac{1}{40}$th to $\frac{1}{12}$th grain of arsenic per pound (3·5 to 11·9 parts per million), and some of those arsenical specimens apparently have been of recent manufacture. But such instances have been few, and we have evidence that glucose supplied to brewers has lately been almost uniformly satisfactory as regards arsenic. Some 500 specimens of such glucose have been tested at the Government Laboratory since the issue of our first report. In the majority no arsenic was detected; and in the remainder, with only two exceptions, the amount of arsenic present was below $\frac{1}{250}$th grain per pound (·57 parts per million).

Ling, 10,576, 10,632.
Primrose, 11,847 (Table II.)
Appx. 24, p. 235.
Primrose, 11,847.

"Invert" Sugar.

73. The "invert" sugar which is used by brewers (and sometimes also in the preparation of cider and of certain fermented "non-intoxicating" beverages) is manufactured in this country on a considerable scale by subjecting cane or beet sugar to an "inversion" process in which sulphuric acid is added to the sugar. At the works of Bostock and Co., about 3 per cent. of sulphuric acid was used for this purpose, and the "invert" sugar produced in 1900 contained large amounts of arsenic (estimated in different specimens from 1·4 to 4·3 grains per pound).

Tattersall, 20.
C. Brown, 6709.
Hooper, 7869.
Delepine, Appx. 12, p. 349.

74. Contamination of "invert" sugar by arsenic is avoidable by the exercise of due care on the part of the manufacturer to secure that a pure acid is used in the process. We have evidence that a large number of samples of "invert" sugar have been recently examined for arsenic at the Government Laboratory with negative results. Other samples also recently tested there have shown only small quantities of arsenic, in nearly all cases below $\frac{1}{250}$th grain per pound.

Primrose, 11,847.

Glycerine.

75. Glycerine is of importance in view of its use in various articles of confectionery, and also as an ingredient of certain kinds of cake.

Glycerine which has been prepared by distillation of the crude glycerine derived from soap makers' lyes may contain considerable amounts of arsenic derived mainly from the hydrochloric acid used in the manufacture of the crude product.

Appx. 24, pp. 233, 255.

For pharmaceutical or food purposes the arsenic can be removed from glycerine so prepared by suitable processes at the glycerine distillery, and glycerine which has been thoroughly de-arsenicated, as also glycerine which has been prepared by hydrolysis, habitually shows either no trace of arsenic, or else any arsenic present is too small in amount to be detected by the Gutzeit test which the British Pharmacopœia, 1898, directs to be applied to pharmacopœial glycerine. It should however be observed that doubts have been expressed as to the sufficiency of this pharmacopœial test. It has

C. Brown, p. 255.
H. Smith, 10,916-8.

been stated that this test may fail to detect quantities of arsenic which though comparatively small are nevertheless easily avoidable and also that the quantity of arsenic which would transgress the limit defined by this test is somewhat uncertain. We have been in communication with the Pharmacopœial Committee of the General Medical Council with reference to this matter, and we understand that the sufficiency of the official test for arsenic in glycerine is now under their consideration.

Appx. 24, p. 233.

76. Glycerine supplied for pharmaceutical and domestic purposes has occasionally been found to contain much arsenic: for example, 1 grain or more of arsenic per pound (143 parts per million), and exceptionally even 3 or 4 grains per pound, have been reported by different analysts within recent years. We have evidence from public analysts and others that shortly after the 1900 epidemic a number of samples of British and foreign made glycerine sold for pharmaceutical purposes were tested for arsenic, and that objectionable quantities of arsenic, though smaller than those above mentioned, were found in certain of these samples.

Colouring Matters.

Mineral Colouring Matters.

Helmer, 8015–8.
Pronk, 11,402, 11,443.
Howell, 11,250–3.
Hehner, 10,210, Appx. 27, p. 277.

77. The principal mineral colouring matters used in food are oxide of iron, and substances sold under various names ("Bole Armenia" and the like), which consist mainly of oxide of iron. Owing to the method by which oxide of iron is prepared such colouring matters habitually contain arsenic in considerable amount. The reported instances include a sample of "Bole Armenia" on sale at one of the London Stores in 1902, which was found by Dr. McGowan to contain $\frac{4}{5}$ths grain of arsenic per pound, and a sample of oxide of iron used as an addition to cocoa, which in June last was reported by Mr. Hehner to be "immensely arsenical."

Appx. 24, p. 234
Appx. 25, p. 268.
Appx. 27, p. 277.

Oxide of manganese, another mineral colouring matter sometimes used in food, has also been found to be contaminated by arsenic.*

Hehner, 10,210.

Coal-tar Colouring Matters.

Pronk, 11,373.
Appx. 24, p. 234.

78. Arsenic has been used in the process of manufacture of certain coal-tar colours, particularly magenta dyes, and such colours have been found to be highly contaminated by arsenic. But this method of preparation of magenta dyes appears to be seldom employed at the present day. A variety of coal-tar colours are however liable to contain arsenic, which probably has been derived from the sulphuric acid used in their preparation. Instances in which the quantity of arsenic detected in coal tar colours used by sweet manufacturers has been as much as, or more than, $\frac{1}{2}$ grain per pound, have been reported to us.

Pronk, 11367, 11,378-83.
Hehner, Appx. 27, p. 277.

Appx. 25, p. 268-9.
Appx. 22, p. 223.

Caramel.

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79. Caramel, which is used to colour and flavour a large number of foods, including some kinds of beer, may contain arsenic as a result of its method of preparation from glucose or cane sugar. The origin of the arsenic has been attributed mainly to the use of impure alkaline carbonates in its manufacture. Considerable quantities of arsenic (in some instances more than $\frac{1}{4}$ grain per pound) have been reported in a number of samples of caramel. On the other hand caramel which is free from arsenic may readily be obtained commercially: numerous analyses have been reported to us which show that caramel samples have shown no arsenic when delicate tests have been applied.

* Coloured salts of arsenic, such as Scheele's Green or Emerald Green, are so notoriously poisonous that it may be assumed that they are never used in food, and are avoided by manufacturers of toys or other articles which may be given to children or used about the house. The use of emerald green to colour wax tapers or candles appears to us objectionable and dangerous. Mr. William Thomson informed us last year that he had detected as much as 5·32 *per cent.* of arsenious oxide in green tapers thus coloured.

Lynge, 11,769-73.

Phosphoric Acid and Phosphates.

80. Phosphoric acid and phosphates are used in the preparation of a variety of food substances: for example phosphoric acid is used in sugar refining and in mineral waters, and phosphates in baking powders. Commercial phosphoric acid and commercial phosphates, both of British and foreign manufacture, are liable to contain arsenic, largely derived from sulphuric acid used in their preparation. These substances, as sold by druggists and as supplied to food manufacturers, have frequently been found to contain arsenic in notable amount. *Appx. 24, p. 231-2.* Stevenson, 2381-6. Davis, 6455. *Appx. 24, p. 231.* *Appx. 25, p. 265.*

81. There appears, however, to be little difficulty in obtaining commercially phosphoric acid and phosphates which are comparatively pure as regards arsenic. Thus one manufacturer who tests for arsenic systematically, informed us that he habitually obtains phosphoric acid containing less arsenic than 2 parts per million ($\frac{1}{7}$2nd grain per pound), and we have evidence that since attention was directed to the subject in 1900 the phosphates sold to druggists and for food purposes have been generally purer in respect of arsenic than was formerly the case. *Lyle, 11,039, 11,042-4 11,095.*

Boric Acid and Borates.

82. Boric acid and borates are largely used in preserving meat and fish, and are also often added in considerable amount to butter, milk, and other foods. Many analysts have reported to us the detection of arsenic in commercial borax and boric acid to the extent of $\frac{1}{10}$th grain per pound (14 parts per million), or thereabouts; in some samples of borax over $\frac{1}{3}$rd of a grain of arsenic in the pound has been reported. Stevenson, 2358-60. *Appx. 24, p. 233.*

83. "Chemically pure" borax and boric acid, free from arsenic, are prepared by suitable processes of purification. In practice, however, the borax and boric acid which are used as food preservatives are of the cheaper "commercial," not the "chemically pure" variety.

Other Chemical Substances used in Food.

84. Considerable quantities of arsenic have been determined in certain samples of beer "regenerators" and "neutralisers," consisting mainly of alkaline carbonates used for the treatment of beer which is becoming sour; in samples of materials used for hardening brewing water, which consist largely of sulphates, carbonates, and chlorides; in "Kainit," a natural earth used for the same purpose; and in a few samples of "malto-peptones," yeast foods which consist essentially of soluble phosphates associated with nitrogenous matter. There appears, however, to be little difficulty in obtaining purity in the case of these and other chemical substances used in connection with brewing. A large number of such substances have been examined in the Government Laboratory since the issue of our First Report. In many, no arsenic has been detected; and in most of the remaining samples the arsenic present has been estimated at less than $\frac{1}{250}$th grain per pound, or in the case of liquids, less than $\frac{1}{100}$th grain per gallon. *Primrose, 11,847, Table II. 11,869-73.* Briant, 7224. *Primrose, 11,847, Table I.*

85. The liability of tartaric and citric acids to contain arsenic, in consequence of the use in their manufacture of large quantities of sulphuric acid, has been frequently mentioned in evidence, and we have been informed that small amounts of arsenic have been detected in certain samples, including some of foreign manufacture. We have evidence that care is taken by firms manufacturing these substances to obtain sulphuric acid which is free from arsenic, and that the stringent precautions against contamination by lead which are usually taken would also remove arsenic if present. Kirkby, 3704. Davis, 6423. *Thompson, 9069.* *Howell, 11,218.* *Appx. 24, p. 232.* *Appx. 25, p. 265-6.*

Appx. 24, p. 253.

86. Acetic acid, sulphurous acid, and bisulphites—used in the preparation of a variety of food substances—have also in a few instances been reported to contain small amounts of arsenic.

Malt.

Estcourt, 3982.
C. Brown, 6709-10, 6768.
Hooper, 7880-2.
H. Smith, 8650.
Thomson, 9669, 9691.
Fairley, 9855.

87. The liability of malt to be contaminated by arsenic was first recognised after the cause of the 1900 epidemic had been ascertained. Considerable amounts of arsenic have been reported by different witnesses to have been found in malt: as much as $\frac{1}{20}$th grain and exceptionally even $\frac{1}{6}$th grain of arsenic per pound have been detected in some samples, while numerous analyses have been reported to us in which the malt has been found to contain from $\frac{1}{100}$th to $\frac{1}{30}$th of a grain of arsenic per pound. As stated in Part I. of this Report, the presence of notable quantities of arsenic in malt has been confirmed by analyses of beer in which it seems certain that no arsenic was introduced otherwise than by way of the malt used.

H. Smith, 8665.
Worsick, 9441.
Thomson, 9758.
Fairley, 9853.
Salamon, 9994.
Chapman, 10,282.
Ling, 10,684.
Primrose, 11,847.

88. The question of arsenic in malt has lately received close attention from brewers and maltsters, and malts as a whole have in consequence improved in this respect. All our evidence goes to show that it is now commercially practicable to produce malt which either may be considered free from arsenic, or in which the amount of arsenic present is certainly less than $\frac{1}{250}$th grain per pound (·57 parts per million), and that most of the malt prepared during the past two years has been of this character.

89. The exclusion of small quantities of arsenic from malt has proved a matter of considerable difficulty, and consequently we refer to it here at somewhat greater length than in the case of other ingredients of food.

90. The coal or coke used for malt drying always contains arsenic. When the fuel is burnt on the fire of an ordinary malt kiln, part of the arsenic is volatilised, and much of the arsenious oxide which is formed becomes condensed or deposited on the internal surface of the kiln, on the malt floor, or in the malt. Part of the arsenic remains behind in the ash in combination (as arseniate) with basic matter contained in the fuel. Some of this ash, carried up by a strong draught, may become deposited in the malt and so add to the quantity of arsenic which the latter contains.

Thorpe, 11,696.
Ling, 10,570-3, 10,704.
Beaven, 10,805-11.

91. We have received a considerable amount of evidence from maltsters and chemists as to methods which have been tried and adopted in order to obtain malt which is free from arsenic; and we now briefly refer to the ways in which it has been found that access of arsenic to malt may be obviated or diminished.

Malting without Access of Products of Combustion.

92. It is evident that if malt is dried by means of heated air, without any admixture of the products of combustion, no difficulty with regard to arsenic can arise. As stated in our First Report, we have evidence from both brewers and maltsters that according to general belief it is essential that the products of combustion should pass through the malt in order that it may possess a flavour which is necessary for beer. We have not received sufficient experimental evidence to enable us to give a satisfactory answer to the question whether flavour is in fact dependent on the fumes from the fire, and if so, whether, in order to obtain the flavour desired, it is necessary to pass the products of combustion through the grain during the whole of the time in which it is drying on the kiln.

Vol. I., Index, "Malt."
Thomson, 9697-8.
Salamon, 9980.
Ling, 10,695-12.
Beaven, 10,735-70.

The expense involved in altering the structure of ordinary malt kilns in order that the malt may be dried solely by means of heated air would be very considerable, and this consideration itself may be expected to prevent any immediate general adoption of this means of

Salamon, 9989.

producing malt which is free from arsenic. Since our first Report was published, however, we have received descriptions and specifications of various processes for drying malt on the kiln without access of fumes from the fire. These and other methods no doubt require to be tried on a considerable working scale at English maltings before sufficient experience can be gained of their advantages or disadvantages from the point of view of the cost involved, and of the extent to which they meet the requirements of the brewer, and the demands of the public taste. But so far as the exclusion of arsenic and the wider choice of fuel are concerned, the advantage is unquestionable, and it is obviously important that processes of malting without the products of combustion should in future receive careful attention from brewers and maltsters who are about to erect new malt kilns.

Selection of Fuel.

93. As stated in Part I. of this Report, it has long been the custom in many parts of England and Wales to use nothing but anthracite for drying malt. Elsewhere, especially in Yorkshire and Midland maltings, oven coke and gas coke were often the principal fuels used up to 1901—largely no doubt because their local abundance and the remoteness of the anthracite collieries combined to make the difference in cost considerable. In that year the liability of malt to be arsenical became generally understood, and it was speedily recognised that the most arsenical malts were those which had been dried over gas coke, whereas anthracite-dried malts, as a rule, were comparatively little contaminated by arsenic. As a result the use of gas coke for malt drying has been largely discontinued. The use of oven coke also has been discontinued to a considerable extent. The exclusive use of anthracite for malting was strongly recommended to brewers and maltsters by the Expert Committee appointed by the Manchester Brewers' Association, in their final Report issued in May, 1901.

94. Although at the date of our first Report we had received an abundance of evidence which showed the objectionable character of certain gas cokes and the relative advantages of using anthracite, we were without information as to the extent to which arsenic may occur in anthracites used for malting. Few examinations of such anthracites appeared to have been made; moreover, satisfactory methods of estimating small quantities of arsenic in fuels had still to be worked out. Since that date we have instituted inquiries into the subject and have received further evidence. In Appendix No. 30 will be found a series of reports relating to arsenic in coals obtained from the anthracitic region of South Wales from which the great bulk of anthracite used for malting in this country is obtained. This Appendix embodies information supplied to us by Mr. A. Strahan, of the Geological Survey, regarding the appearance and geological correspondence of the seams of anthracite worked at various collieries which he visited for the purpose of our inquiry, the distribution and nature of the "impurities" associated with anthracite in certain of these seams, and the practice of the collieries visited in respect of the removal of impurities from the coal which they supply to maltsters.

Tomson, 3100–6, 3161.
Deakin, 3881.
O'Sullivan, 5743.
Earp, 7111, 7171.
H. Smith, 8724.
Thompson, 9058.
Buckley, 9292, 9368-73.
Worsick, 9425.
Thomson, 9692.
Appx. 19, p. 204.

Ling, 10,446-536.
Thomson, 9784-9.
Salamon, 9984, 10,059.
Chapman, 10,353-67.

Appx. 30, pp. 286-325.

From these collieries a large number of samples were carefully collected for the Commission by Mr. S. Warren Price (Lecturer on Mining at University College, Cardiff), who subsequently furnished a report showing in detail the steps which he took to secure that these samples were comparable and properly representative. They comprised a series of anthracites as prepared at the colliery for sale to maltsters, a second series obtained underground from the different seams of anthracite worked at the various collieries, and a third series representing characteristic "impurities" associated with anthracite, which are capable of being removed from the coal either by the miner underground or by hand-picking at the surface.

All the samples thus obtained were tested for arsenic in Dr. McGowan's laboratory by a method of analysis (based on that of

Messrs. Newlands and Ling) which he describes in detail (Appendix 23), and which he had found to give accurate results.

Appx. 23, p. 227.

95. These reports on malting anthracite deserve attention from brewers and maltsters and also from colliery proprietors and managers. They afford a considerable collection of comparable data regarding representative specimens, which should prove valuable for reference in connection with future chemical examinations of anthracites for arsenic; while the indications which have been obtained by these investigations afford useful guidance on various matters which require attention in the selection of anthracite for malting purposes.

Appx. 30, p. 290.

96. In particular they show the great importance as regards arsenic of thoroughly and systematically removing all "impurities" from anthracite used in malting. The amount of arsenic found in the large number of different samples of "clean" anthracite was relatively small—in almost all cases it was below 10 parts per million (·07 grain per pound)—whereas many of the "impurities" associated with the anthracite contained comparatively large quantities of arsenic. The impurities in question comprised not only yellow pyrites, or "brasses," which are generally known to be liable to contain much arsenic, but also certain samples of impure coal consisting largely of shale, and well-marked bands of black, granular, impure coal, which show little or no "brassy" pyrites. As a rule satisfactory removal of the above impurities, where present, is effected readily enough if suitable appliances are used and proper supervision is exercised at the colliery In certain circumstances, however—for example, where black granular bands are distributed intermittently throughout the thickness of a seam of anthracite—the matter is one of greater difficulty and requires the exercise of a corresponding amount of care.

Appx. 30, pp. 288.

Appx. 30, pp. 303, 309.

97. *Gas cokes* have been found in many instances to contain large quantities of arsenic. Thus the proportions of arsenic determined by Dr. McGowan in samples of coke taken this year from three gas works in Yorkshire, each of which used formerly to supply maltsters, were respectively 125, 144 and 200 parts per million (0·9, 1·0 and 1·4 grains per pound). Brewers and maltsters as a whole appear to have found little difficulty in abandoning the use of gas coke in 1901, and having regard to the quantities of arsenic found in certain specimens, and to the arsenical contamination of malt which has resulted from the use of gas coke, we are of opinion that this fuel should not be used by maltsters unless in connection with special methods of treatment to which we refer below, and then only after careful selection of the coke.

Vol. I., Index, "Fuels."
Fairley, 9824.
Ling, 10,536.
Appx. 19, p. 203.
Appx. 30, p. 320.

98. We have received a number of analyses of *oven cokes*. Some have contained only small proportions of arsenic, such as those ordinarily met with in clean anthracite; while in others arsenic has been present in considerable quantity, *e.g.*, between 30 and 50 parts per million (0·2 and 0·35 grains per pound). The extent to which oven coke may contain arsenic is determined mainly by the nature of the coking coal from which it is derived and by the amount of care taken, by washing or otherwise, to free the coal from pyrites and other impurities before it is put into the coking oven. The fact of the fuel being oven coke is not in itself a sufficient guarantee of its purity as regards arsenic; the selection by the maltster of satisfactory oven coke will depend upon sufficient information being obtained as to its origin and manufacture, and upon the exercise of the control afforded by frequent analysis of samples.

Ling, 10,536, 10,542-9.
Appx. 30, p. 320.

99. Mr. Ling and others have laid stress upon the importance of determining not only the "total" arsenic contained in samples of malting fuel, but also the proportion of "volatile" arsenic which escapes when the fuel is burnt under laboratory conditions, and the proportion of "fixed" arsenic which remains behind in the ash. Methods by which "fixed" and "volatile" arsenic may be estimated

Ling, 10,451, 10,671-9.

are described in detail in our Minutes, including the form of test recently recommended by the Board of Inland Revenue Departmental Committee, and that which was adopted by Dr. McGowan in analysing fuel samples for the Commission. *Ling, 10,451. Appx. 21, pp. 210, 214. Appx. 23, p. 227.*

In the case of anthracite, and also of coke, the proportion of "volatile" to "total" arsenic appears to vary considerably in different specimens tested under identical conditions. In general it has been found that the proportion of arsenic volatilised under experimental conditions of combustion is less in the case of cokes than in the case of anthracite. The experimental evidence which we have received, however, is not sufficient to determine the extent to which particular processes of estimating "volatile" arsenic in the laboratory can be relied upon to furnish an index of the proportion of arsenic which will become volatilised when the fuel is burnt, under varying conditions, on the fire of the malt kiln. *Appx. 30, p. 289 Ling, 10,536. Thorpe, 11,701* *Appx. 30, pp. 290, 325.*

Treatment of Fuel.

100. Processes have lately been devised for utilising the property possessed by lime, in common with other basic substances, of absorbing and "fixing" arsenic. We have received evidence as to a practice suggested by Mr. Newlands and applicable particularly to coke, in which the fuel, before being put into the kiln fire, is intimately mixed with the base by the addition of milk of lime. Mr. Beaven has also described an arrangement by which lumps of limestone are placed at the outlet of the kiln furnace. He claims that the fumes from the fire, in passing over the surfaces of heated lime thus provided, lose practically all the arsenic they contain. *Ling, 10,555-69, 10,589-95, 10,669. Buckley, 9316.* *Beaven, Appx. 18, p. 199.*

Cleansing of Kilns.

101. Sweepings from the inner walls, girders, dispersing plates, and other parts of malt kilns have been found to contain surprisingly large quantities of arsenic. The liability of malt to become arsenical is greatly increased when such dust is allowed to accumulate on any of these surfaces, either below or above the malt floor. For safety it is imperative that the interior of kilns should be thoroughly cleansed, not only when they are first taken into use at the beginning of the malting season, but also at frequent intervals as the season progresses. *Fairley, 9824, 9859, 9905, 9920. Salamon, 9988, 9996. Thompson, 8954, 9017. H. Smith, 8753. Buckley, 9412. Worsick, 9478. Ling, 10,570, 10,688. Appx. 30, Part VI.*

Construction of Kilns.

102. Malt kilns differ greatly in their construction; for example, in the height of the malting floor above the fire, in the number of malting floors, in the construction of the furnace, and in many other ways. There is no doubt that, other things being equal, the structure of some kilns tends to greater risk of arsenical contamination than that of others. We have evidence that maltsters in dealing with the question of arsenic in malt have in some cases found advantage in making various structural alterations in their kilns. Thus, in some instances dispersing plates and screens have been provided, which serve to condense some of the arsenious oxide which has been volatilised, and also to arrest some of the dust carried up by the current of hot air from sides of the kiln or from the furnace. In other instances alterations have been made in the openings of the kiln in order that a considerable proportion of the hot air passing through the malt may be raised to the necessary temperature without contact with the fire. *Beaven, 10,709-910.*

Screening and Brushing of Malt.

103. All brewers' malt is screened to separate the rootlets or culms, and in this process a certain amount of the arsenic deposited on the grain may be mechanically removed. It is important that screening should be thoroughly carried out, as it has been shown that the culms often contain relatively considerable quantities of arsenic. The brushing Vol. I., Index, "Malt."

Vol. I., Index, "Malt."
Worsick, 9457.
Thomson, 9780.
Fairley, 9863.
Salamon, 10,018.

machinery which is in use at a good many maltings and breweries is capable of removing a considerable proportion of the arsenic from arsenical malt, especially where the brushing is repeated several times. It is, however, obviously preferable to take steps to prevent the access of arsenic to malt, rather than to rely on any subsequent process for removing arsenic after it has become deposited on the grain.

Hops.

Vol. I., Index, "Hops."
Appx. 19, p. 202.
Thomson, 9669.
Primrose, 11,847.

104. Hops are exposed to the products of combustion of fuel during their drying on the kiln, and it has also been suggested that they may become contaminated through the use of impure sulphur (on the kiln or as an insecticide) and possibly in other ways.

It is the practice of hop driers to employ anthracite, and not coke, for burning in the kiln, and if suitable care is exercised in the selection of fuel the risk of hops becoming contaminated is evidently small. The quantities of arsenic which have been reported to us as having been detected in hops have in all cases been minute.

Finished Foods which are Liable to Arsenical Contamination.

105. The following are the chief foods, or kinds of foods, which our evidence has shown to be liable to arsenical contamination, through the use of the above ingredients or in other ways, in the absence of sufficient precautions.

Beer.

106. The liability of beer to be contaminated by arsenic arises mainly through the use in brewing of arsenical glucose, invert sugar, and malt, or by the addition of arsenical invert sugar or glucose as "priming" after the wort has been fermented. The degree of contamination which may arise in these ways is abundantly illustrated in our evidence.

Vol. I., Index, "Priming."

Since the 1900 epidemic and the appointment of this Commission close attention has been given by brewers to the exclusion of arsenic from these and other substances used in brewing, and various precautions have been extensively adopted with the object of eliminating all risk of arsenical contamination of beer. We have referred in the first part of this report to evidence that, notwithstanding the general adoption of these precautions beer has been occasionally met with in which notable amounts of arsenic (for example $\frac{1}{20}$th or $\frac{1}{30}$th grain per gallon) have been found. But such instances at the present time may be considered quite unusual. We are satisfied from the evidence received during the later part of our enquiry that much of the beer sent out at the present time from breweries in this country may be regarded as free from arsenic, and that arsenic, where detected, is usually in minute amount. All the chemical witnesses from whom we have recently had evidence (including responsible chemical advisers of breweries) have been agreed that it is commercially practicable to produce beer which uniformly shows less arsenic than $\frac{1}{100}$th grain per gallon, and in which as a rule any arsenic present is in much smaller proportion than this.

cf. para. 21, above.
Thomson, 9669, 9758.
Fairley, 9852, 9923.
Primrose, 11,847.

Salamon, 9966.
Hehner, 10,169-78.
Chapman, 10,279.
Primrose, 11,847.
Allen, 11,973.

Golden Syrup and Treacle.

107. In the preparation of these substances from cane or beet sugar it is customary to "invert" the sugar to a greater or less degree by the addition of mineral acids, in order to prevent crystallization. About two per cent. of sulphuric acid is frequently used for this purpose. The high degree of arsenical contamination which may result if the sulphuric acid used is arsenical, has been shown in the case of the "Table Syrups" which Messrs. Bostock and Co. began to manufacture in 1900 (paragraph 7). Contamination of syrups of this kind by arsenic can be readily prevented by the exercise of strict care in the selection and testing of the sulphuric acid used, and by attention also to the purity of other substances used in the manufacture (such as hydrochloric or phosphoric acids), which are liable to contain arsenic.

Appx. 24, p. 238.
Lyle, 11,928–160.

H. Smith, 10971.

108. The evidence which we have received regarding the manufacture of this class of syrup shows that before the 1900 epidemic, precautions were adopted by manufacturers in this country to ensure that the mineral acids employed were satisfactory as regards arsenic, and that since the epidemic additional safeguards have been provided with satisfactory results. One important manufacturer of "golden syrup," who gave evidence as to the precautions adopted in his factory, informed us that as a result of numerous analyses it had been found that if any arsenic was detected in the syrup, the amount was invariably minute; for example "nothing approaching one part of arsenic per million" ($\frac{1}{143}$rd grain per pound) had ever been discovered in any sample of the syrup. *Lyle, 11,114–5.*

Foods containing Glucose.

109. Glucose is an ingredient of a large variety of food substances. Certain syrups sold as "table syrup," "amber syrup," and the like, consist largely of liquid glucose. Jams and marmalade frequently contain from 5 to 10 per cent. of glucose, and sometimes larger amounts. Glucose may be mixed with honey, or used as a basis for the manufacture of "artificial honey." Certain kinds of sweets and confectionery, again, consist largely of glucose. *Appx. 24, pp. 238–243. Walker, 11,321–2.*

110. A large number of these foods, particularly sweets and confectionery, were tested for arsenic by public analysts shortly after the 1900 epidemic, and it is satisfactory that arsenic was detected in hardly any of them. Having regard, however, to the evidence which we have received as to glucose, and to reported instances in which material quantities of arsenic have been determined in samples of imported liquid glucose of the kind commonly used by confectioners, it is evident that foods of this class, in the absence of sufficient analytical control, are subject to risk of serious contamination by arsenic. We have evidence that since attention has been drawn to the subject certain manufacturers have taken steps to obtain guarantees of purity of the glucose which they purchase from the manufacturer, importer, or middleman, and that others have from time to time caused samples of the glucose to be tested for arsenic. On the other hand, certain manufacturers whose products contain large proportions of glucose appear to have considered it unnecessary to take any steps to assure themselves by analysis that their glucose was satisfactory in respect of arsenic, notwithstanding the circumstances of the epidemic of 1900. *Appx. 24, p. 236. Walker, 11,308–31.*

Vinegar.

111. At some vinegar factories the principal material from which vinegar is made consists of raw grain (rice or maize) which has undergone a process of "conversion" in which sulphuric acid is used in much the same way as in the manufacture of glucose. Our inquiries show that at vinegar factories where "converted" grain is used, precautions have been taken since the 1900 epidemic to obtain acid which is satisfactory as to arsenic. *Appx. 24, p. 246.*

Other substances liable to contain arsenic may be used in vinegar manufacture, for example, malt and sour beer.

Demerara Sugar.

112. We have evidence that small quantities of arsenic—exceptionally as much as $\frac{1}{50}$th and $\frac{1}{60}$th grain per pound—have been detected in samples of "Demerara" sugar coming from the West Indies. *Appx. 24, p. 239.*

It has been suggested that the presence of arsenic in such samples is attributable to the use in their manufacture of arsenical phosphoric acid, or of chloride of tin (a salt which may contain arsenic as an impurity), which is frequently used in the West Indies to give a characteristic "bloom" and colour to the sugar.

113. Other samples of brown sugar, both from the West Indies and from English refineries, when tested by a delicate test capable of detecting $\frac{1}{1000}$th grain per pound, have been found free, or practically free, from arsenic.

Lyle, 11,069.
Appx. 25, p. 264.

Foods, other than Beer, prepared from Malt and Yeast.

114. Various extracts of malt, "maltine" and the like, are manufactured for sale to invalids, and are also used by bakers. Prepared foods under a variety of names have lately come on the market, and are being extensively used, which are recommended to the public by the manufacturers on the ground that they will provide a meal without cooking or other preparation. In these foods malt is frequently an important ingredient. Malt also enters largely into the preparation of certain "infant foods."

Appx. 24, p. 245.

The number of cases reported to us in which foods prepared from malt have been tested for arsenic has been comparatively small. Arsenic has been recognised to be present in certain samples, but others, including four examined by Dr. McGowan, have been found free from arsenic when subjected to delicate tests. Mr. Hammond Smith has reported to us that certain British manufacturers whom he visited have lately controlled the purity of the malt used by frequent analysis, or at least by obtaining a guarantee as to arsenic from the maltster. Most of the foods in question, however, are manufactured abroad, mainly in America, and we have not been able to obtain satisfactory information as to the nature of the precautions, if any, which are adopted by American maltsters or manufacturers of malt foods.

Appx. 24, p. 245.
Primrose, 11,847, Table II.
Appx. 25, p. 262.

Appx. 26, p. 276.
H. Smith, 10,935.

115. Yeast takes up arsenic when grown in an arsenical wort. The utilisation of yeast as an article of human food appears to have been receiving attention in recent years, and foods have been manufactured in which yeast is a principal ingredient. We have received evidence from the manufacturer of a food termed "Carnos," made from yeast and malt culms obtained from a Yorkshire brewery, that this preparation was frequently found to contain $\frac{1}{30}$th grain of arsenic to the pound after the epidemic of 1900, notwithstanding the adoption of a series of precautions to prevent arsenical contamination. In four different samples of "Carnos" Dr. McGowan found from $\frac{1}{25}$th to $\frac{1}{6}$th grain of arsenic per pound. This food was not at any time largely sold, and we understand that its manufacture has now ceased altogether.

Appx. 24, p. 244.
Appx. 25, p. 262.
Overbeck, 11,260–307.

Foods containing Glycerine.

116. Glycerine is sometimes used in the manufacture of cakes to the extent of one to three per cent. of the materials employed, in order to keep them moist. A few meat extracts contain a large proportion of glycerine, and it is also used in some kinds of confectionery. In these foods material quantities of arsenic might be introduced through the use of impure glycerine. Our evidence shows that some food manufacturers using glycerine stipulate that it should be "pure" or "suitable for food purposes," or that it should be of Pharmacopœial quality. It appears, however, that the liability of glycerine to contain arsenic is not known to many manufacturers who use this substance in the preparation of food.

Appx. 24, p. 243.
Palmer, 11,456–79.
Appx. 24, pp. 240, 244.

H. Smith, 10,923.

Foods in which Certain Colouring Matters and Preservatives are used.

117. Bole Armenia and other mineral colouring matters consisting mainly of oxide of iron are frequently added in considerable proportion in the preparation of a variety of foods, for example sausages, anchovy preparations, cocoa, and certain kinds of sweets. Material quantities of arsenic may be contributed to these substances in this way. Thus Mr. Hehner, in June of this year, informed us that he had estimated

Appx. 24, p. 247.
Appx. 27, p. 277.

approximately $\frac{1}{20}$th or $\frac{1}{25}$th grain of arsenic per pound in a "chocolate powder" largely sold in London at a cheap price, which had been contaminated by arsenic through the use of oxide of iron. He also estimated the arsenic in certain sweets, similarly coloured, at $\frac{1}{30}$th grain per pound. Arsenical contamination of various coloured foods may also arise from the use of arsenical coal tar colours or arsenical caramel. *cf.* para. 78 above.

118. The addition of large quantities of boron preservatives to foods likewise entails risk of their becoming contaminated by arsenic, and arsenic detected in certain foods has in some instances been traced to these preservatives. *Appx. 24, p. 248.*

MISCELLANEOUS.

119. Instances have been reported to us in which the presence of small quantities of arsenic have been determined in gelatine (in consequence of the use of impure sulphuric acid in its manufacture) and in liquorice sweets (possibly through the addition of impure glucose, or to the use of sulphuric acid or glycerine in the manufacture of the liquorice stick) *Appx. 24, p. 239* *Thomson, 9794.* *Appx. 24, p. 241.*

120. We have made inquiries concerning foods which are dried or otherwise prepared by exposure to the fumes of coal or coke. In many localities and factories gas coke is used to dry bloaters and hams. But these substances are exposed to the fumes to a small extent by comparison with malt ; moreover the surface exposed is relatively small, and the arsenic would be deposited mainly on the outside skin, which is not eaten. The arsenical contamination which might arise in these cases appears to us inconsiderable, and such experimental evidence as we have received supports this view. Similarly, no appreciable contamination seems likely to occur in the case of food grilled over an open fire. *Appx. 24, pp. 249,250.* *Appx. 25, pp. 270-3.*

121. On the other hand chicory should be specially mentioned, as the process of drying chicory roots is similar to that of drying malt, and where coke is used on the drying kiln (as is said to be usual in Belgium and the North of France), the chicory is liable to become contaminated by arsenic. Our information as to analyses of chicory for arsenic is limited to a few specimens, in which the place of manufacture and the nature of the fuel used was not ascertained. Two of these samples showed about $\frac{1}{100}$th grain of arsenic per pound. *Appx. 24, p. 250.* *Thomson, 9790.* *H. Smith, 10,995.*

INQUIRIES AS TO RISKS FROM ARSENIC, THE RESULTS OF WHICH HAVE BEEN NEGATIVE.

122. Reference will be found in our evidence and in Mr. Hammond Smith's report to certain ways in which it has been suggested that risk of arsenical contamination of food may arise, but where no evidence of such risk has been obtained on inquiry.

Contamination of Cereals or Roots grown on Arsenical Soil.

123. Manuring with commercial superphosphates, which commonly contain considerable amounts of arsenic, has been supposed to entail risk of contamination of cereals or roots. Dr. J. A. Voelcker, Consulting Chemist of the Royal Agricultural Society of England, this year reported to us the results of a valuable series of experiments on this question. At the Society's experimental farm at Woburn, barley and swedes were grown on several quarter-acre plots which had been respectively manured with superphosphate containing no arsenic, manured with superphosphates containing various known proportions of arsenic, and left unmanured. In the ripe crop, minute amounts of arsenic were detected in all cases in the barley straw and (in the one case examined) in the leaves of the swedes. But no arsenic was detected by a delicate test capable of detecting $\frac{1}{1000}$th grain per lb. (·14 parts per million) in any sample of the barley grain, or of the bulbs of the swedes. In the previous year, 1902, we also received an interesting account from Stevenson, 2309-13. *Appx. 19, p. 202.* *Fairley, 9824.* *Salamon, 9999, 10,016.* *Voelcker, 12,073-163*

Angell, 8463-8627.

Mr. A. Angell, of experiments which he and Mr. A. F. Angell had made in the same direction. As a result of these experiments, which were carried out on a smaller scale and with a greater variety of vegetables than those at Woburn, Mr. Angell reported that he had been unable to detect arsenic in the ripe grain or in the fruit or seed of any one of a considerable number of plants grown on soil previously manured with a specially arsenicated superphosphate.

Contamination of Spirits by the addition of Mineral Acid.

Appx. 24, p. 231.
Appx. 28, p. 278.

124. It has often been stated to be a practice of publicans, particularly in the poorest neighbourhoods of London, to add mineral acid to gin or whisky, to give them a "nip" appreciated by a certain class of customers, and the possibility of arsenic being introduced in this way has been suggested in connection with the occurrence of alcoholic neuritis among spirit drinkers. Last year, on the recommendation of the London County Council, a large number of samples of spirits obtained from public-houses in poorer parts of London were submitted by Borough Councils to their public analysts for examination for mineral acid and for arsenic. The results were uniformly negative.

Use of Arsenic in fattening Poultry.

Appx. 24, p. 251.
Appx. 25, p. 273.
H. Smith, 10,997-11,007.

125. It has been suggested that if arsenic is administered to poultry to fatten them for market (as is said sometimes to be the case) the flesh of the birds may become contaminated. Certain experiments on which Mr. Hammond Smith and Dr. McGowan report, however, negative the suggestion of risk arising in this way.

In view of the evidence of the elimination of arsenic in man by the hair, it is of interest to mention that in these experiments a considerable proportion of arsenic was detected in the feathers of fowls which had been given small doses of arsenic for several weeks.

Use of Arsenic in the Enamel of Cooking Utensils.

126. Arsenic was formerly employed as an ingredient of the enamel of saucepans and other cooking utensils, and it has been shown that liquids boiled in such utensils may take up considerable quantities of arsenic.

H. Smith, 11,008.
Appx. 29, pp. 281-5.

Statements having been made that cooking utensils in which arsenic is contained in the enamel are still occasionally sold, we took steps to obtain a series of saucepans and other specimens of enamelled hollow-ware from a number of different sources. Twenty-six of these specimens, coming from at least 14 different factories, British and foreign, were examined by Dr. McGowan, who reported that arsenic had not been used as an ingredient of the enamel in any instance.

Certain "Prepared Foods."

H. Smith, 10,935.
Appx. 24.

127. In a few instances we have made inquiries, with negative results, concerning the process of manufacture of certain prepared foods, for example "meat extracts," prepared cereal foods, and "milk foods," with a view to ascertain whether their mode of manufacture or the nature of their ingredients involve any risk of contamination by arsenic. It must, however, be remembered that foods of this kind are as a rule sold in bottles, tins, or packets, under registered trade names, which give no indication of the nature or mode of preparation of the food substances which they contain, and it is often difficult, and in the case of imported foods it is in present circumstances practically impossible, to obtain accurate information on these points.

PART V.

PRECAUTIONS WHICH SHOULD BE TAKEN BY MANUFACTURERS TO EXCLUDE ARSENIC FROM FOODS.

128. It will appear from the foregoing Part (IV.) of this Report that in many instances manufacturers of foods, and of substances used in the preparation of foods, which are liable to be contaminated by arsenic, have realized the necessity of taking effectual steps to prevent the presence of arsenic in their products. We do not doubt that manufacturers, as a whole, are desirous of doing whatever may be needful to secure that the articles which they supply for the food of the public should be of satisfactory purity, and we believe that absence of adequate precautions as regards arsenic, where occurring, is largely due, not so much to carelessness (and still less to desire for profit, for little pecuniary advantage could in any case be derived from the use of inferior ingredients containing arsenic), as to want of appreciation of the risks involved. We think it well, therefore, to state what we consider, in the light of the information obtained from our inquiries, to be the duty of the manufacturer of foods or food ingredients when liability to arsenical contamination arises, and this apart altogether from the recommendations which we make below as to improved administration to secure better means of official control in regard of the purity of food.

Ingredients of Food, and Substances used in the Preparation of Food, which are liable to contain Arsenic.

129. We have evidence that before the epidemic of 1900, manufacturers of certain of the ingredients of food noted in Part IV. were in the habit of taking steps to guard against risk from arsenic. The epidemic, and the inquiries of this Commission, have led in numerous instances to precautions being strengthened; for example, glucose, brewing sugars, phosphates, and other food ingredients have recently, as a whole, been much purer as regards arsenic than formerly. Moreover, precautions have now been adopted in the case of malt and other substances, which previously had not been recognized as liable to arsenical contamination.

130. It is satisfactory and reassuring that it has been found commercially practicable to produce for food purposes sulphuric acid, phosphoric acid, glycerine, glucose, "invert" sugar, caramel, and malt, either yielding no arsenic when tests of considerable delicacy are applied, or else not more than such traces of arsenic as are indicated in the foregoing part of this Report. We are of opinion that all manufacturers of these substances should take steps to obtain uniformly degrees of purity at least as high as those which our evidence has shown to be at present commercially attainable, and that they should always be alive to improvements which tend to eliminate even traces of arsenic.

Cf. paras 66, 81, 75, 72, 74, 79, 88, above.

131. It is essential that manufacturers of the above substances, as also of other ingredients of food which are liable to arsenical contamination, should frequently test their products for arsenic, and should keep for their own guidance a systematic record of the results of the testing adopted. Tests used should show not merely that arsenic if present does not transgress some arbitrary standard of purity which the manufacturer finds it convenient or necessary to adopt, but they should be of sufficient delicacy to enable minute amounts of arsenic to be detected and estimated, so that he may be able to know what degree of success his precautions are affording. For this purpose it

Garton 6237-46.
Francis, 7386-9.
H. Smith, 8706.
Lyle, 11,132.
Appx. 24, p. 238.

Hehner, 10,151-4

Cf. paras. 45–62, above.

will ordinarily be best that estimations should be made by comparison of mirrors, obtained either by the zinc and acid method or electrolytically. Application of these methods to various substances has been greatly facilitated by recent work to which we have above alluded (Part. III), and we consider them not only the more accurate, but also little if at all more troublesome in practical application than other and less delicate tests. It is, of course, essential in the case of every substance that a uniform and satisfactory method of obtaining a representative sample should be adopted.

Thomson, 9699.
Salamon, 10,080-6.
Chapman, 10,337-53.
Ling, 10,681-2.
Appx. 24, p. 238.

132. We regard it as essential that any guarantee as to arsenic supplied by the manufacturer of an ingredient of food should be given with full knowledge of the amount of arsenic which, if present, would be detected by the test which he employs, and of the significance, in terms of approximate quantity, of any minute proportions of arsenic which he cannot be certain of excluding by the precautions which he adopts.

133. It may be asked whether a manufacturer is justified in giving to his customers a guarantee as to "freedom from arsenic" in his product, if he knows that minute amounts of arsenic (for example $\frac{1}{500}$th grain per pound in glucose or malt) may occasionally be detected when a delicate test such as the Marsh-Berzelius is applied. We think such a guarantee may reasonably and properly be given, provided always that the manufacturer attaches, and is prepared to inform his customers that he attaches, a definite significance to his statement—in other words, that he can state a definite proportion of arsenic which he has satisfied himself that his product certainly does not contain—and provided also that he does his best to keep out arsenic altogether irrespective of the guaranteed limit.

Vol. I, Index, "Guarantees."
H. Smith, 8794.
Moulton, 9936-9.
Hehner, 10,147-65.
Chapman, 10,326.
Lyle, 11,134-5.
Howell, 11,194-209, 11,248.
Walker, 11,318-9.
Pronk, 11,453.
Palmer, 11,494-6.
Primrose, 11,959-60.

134. The guarantee might, for example, take the form of a statement that the ingredient has been freed from arsenic as far as is practicable, and that any arsenic present in no case exceeds a stated proportion. We think that no substance should be used as an ingredient of food which contains a larger proportion of arsenic than $\frac{1}{100}$th grain per lb. or, in the case of solutions $\frac{1}{100}$ grain per gallon: and it will be seen on reference to the ingredients detailed in Part IV. that in many cases (particularly glucose, see paragraph 72, and malt, see paragraph 88) more stringent limits are now attainable commercially and should be insisted upon. The form of guarantee of "freedom from arsenic" which we think a manufacturer should not employ is one which is arrived at merely by the use of a crude test, of insufficient delicacy, and with an unknown or uncertain significance in terms of the quantity of arsenic which it will detect.

135. It is important also that guarantees as regards arsenic should not be given unless tests are applied systematically and with sufficient frequency. Giving such guarantees should not be allowed to degenerate into a perfunctory routine.

Vol. I, Index, "Official control."
Thomson, 9809-15.
Moulton, 9936-9.
Salamon, 10,007-8.
H. Smith, 10,939-49.
Thorpe, 11,720-1.
Allen, 12,073-4.
Appx. 24, p. 254.

136. In respect of ingredients of food, and substances used in the preparation of food, the value and practical utility of guarantees as to "freedom from arsenic" in the above sense would be increased if such guarantees were given on a uniform basis with reference to official "standards," which should define for particular substances the proportions of arsenic, judged by a defined test, which should be regarded as inadmissible. We are satisfied that such standards are needed for the use of manufacturers and users of the substances in question. We make recommendations below as to the means by which they should be established.

Cf. paras. 173–7, below.

137. Certain of the substances here in question are also drugs included in the British Pharmacopœia. At present the tests for arsenic which the British Pharmacopœia directs to be employed are qualitative, and the quantity of substance to which the qualitative tests are to be applied is in nearly every case undefined. The Pharmacopœial

H. Smith, 10,912-8.

Committee of the General Medical Council has now under consideration the question of revising the pharmacopœial tests for arsenic, with the object of giving them a quantitative value, and of adding to the list of drugs which are required to be tested for arsenic*; and they have forwarded to the Commission a preliminary report by Professor Dunstan, who is investigating the subject. It may be anticipated that when this revision has been completed, manufacturers and users of substances for food purposes, which are also pharmacopœial preparations, will find advantage in adopting the pharmacopœial standards inrespect of arsenic.

138. The manufacturer of chemical substances used in the preparation of food (for example, mineral acids, glycerine or colouring matters) frequently prepares the same substances for sundry manufacturing purposes unconnected with food in which the presence of small quantities of arsenic is a matter of relatively less importance. Often indeed supplying substances for use in the preparation of food constitutes only a small part of his business. Wherever practicable in such cases, it is desirable that the manufacturer should take steps to ensure that his product, whether sold for food purposes or not, should uniformly be satisfactory as regards arsenic. Where, however, it is considered necessary to manufacture products which may be arsenical, as well as better qualities of the same substances which are free from arsenic, it is particularly important that the manufacturer should take all practicable steps to ascertain whether the substances he supplies are required for the preparation of food or its ingredients. Dealers or middlemen selling to food manufacturers should make it their business to ascertain from the maker of the food ingredient that the article to be supplied is suitable for food purposes.

Davis, 6410.
Wahl, 7429.
Pronk, 11,431-2.

139. In this connection we would draw attention to the much too prevalent custom of selling chemical substances to food manufacturers under misleading or ambiguous trade names. Instances have been given to us for example in which the sulphuric acid manufacturer has supplied pyrites acid under the name of "brimstone acid," and we understand from the statements which has been made to us on behalf of Messrs. Nicholson & Co. that loose usage of the trade terms for sulphuric acid—"stone acid," "brimstone acid" and the like—is one of the reasons which the firm advances in explanation of the circumstances which led to their supplying arsenical acid to Messrs. Bostock & Co. We have evidence that solutions or preparations of phosphoric acid are largely sold to mineral water makers and to bakers for use in place of the better known, and more expensive, citric and tartaric acids. If these substances were sold avowedly as solutions or preparations of phosphoric acid recommended for use in substitution for citric or tartaric acid, there would be little reason for objection. But we regard it as dishonest that the manufacturer should describe his phosphoric acid preparation by such a name as "liquid tartaric acid," without any intimation of its real nature. Where merely "fancy" names which do not pretend to have any chemical significance are adopted, the manufacturer is less open to criticism than in the case above quoted. It appears to us, however, that the responsibility of the manufacturer for the purity of his products—and this not only in regard to arsenic—is greatly enhanced when he sells chemical substances to food manufacturers under such names.

Tattersall, 21-6.
Davis, 6472-7.
Francis, 7338-41, 7370-4.
Appx. 24, p. 232.
Howell, 11,200-1.

140. It is important that manufacturers of colouring matters used for food purposes should give more attention to excluding arsenic than appears to have been the case hitherto. As shown above, some coal-tar colours used in food have been found to contain considerable quantities of arsenic, and strict precautions should be taken by all colour makers to see that such colours are not supplied for food purposes. Mineral colours (oxide of iron, "Bole Armenia," and

Cf. paras. 77-8, 117, above.

* For example, no test for arsenic is at present required in the case of the reduced iron (ferrum redactum) of the British Pharmacopœia. This drug may contain much arsenic; as much as 1 per cent. has been reported to us in one instance.

Reynolds, 8456-62.

oxide of manganese in particular) frequently contain large quantitie of arsenic. These colours are used in much larger proportion in foods than are coal-tar pigments, and mainly for purposes which we cannot consider desirable (for example, for colouring cheap sausages and some preparations of cocoa and chocolate). We think that, even if free from arsenic, they should not be used in food; their liability to be arsenical affords an additional and important reason for their being abandoned.

Cf. para. 112, above.

141. Chloride of tin is used to give a colour and "bloom" to West India sugars, and no doubt some of the arsenic which has been detected in these sugars, has been introduced in this way. Chloride of tin appears to us an objectionable and unnecessary addition to sugar, and we are of opinion that it should no longer be used.

f. para. 118, above.

142. Similarly with regard to boron preservatives in commercial use. Their employment in large and uncertain quantities, besides being itself objectionable, entails risk of arsenical contamination.

Appx. 24, p. 240.

143. An isolated instance of the use of lanoline in the preparation of food as a substitute for cocoa-butter has come under our notice. In view of the liability of wool grease to be contaminated by arsenic from sheep dip, lanoline seems to be an objectionable substance to use in the preparation of food stuffs.

Finished Foods liable to contain Arsenic.

144. The manufacturer who takes the responsibility of using substances liable to contain arsenic in the preparation of the food which he supplies to the public can guard against arsenical contamination:

(1) By obtaining adequate assurance from the vendor (*see* paragraphs 132–5) that the ingredients which he purchases are satisfactory in respect of arsenic (having regard to the limits which the evidence before the Commission shows to be already practicable), and by taking care that their intended use for food purposes is known to the vendor.

(2) By testing any ingredients which he purchases or himself prepares.

How far in practice sufficient security can be obtained by adopting the first of these precautions, without the second, must depend on the circumstances of particular cases. It can hardly be expected, for example, nor can it be considered essential, that a baker in a small way of business who uses a phosphatic baking powder should frequently submit such a powder to a chemist to be analysed for arsenic. In such a case the food manufacturer must needs place his main reliance upon the care which he has reason to believe is taken by the maker of the ingredient, and upon guarantees of purity which are supplied to him. There are, on the other hand, certain foods as to which we are satisfied from the evidence that it is essential for the food manufacturer to frequently and systematically test his ingredients for arsenic, no matter what may be the nature of the guarantees or of the assurances which he receives from their makers. These are beer, foods in which a considerable proportion of glucose is used (*e.g.*, table syrups, jams, marmalade, and certain forms of confectionery), or which, like glucose, are prepared by the use of a relatively large quantity of sulphuric or hydrochloric acid (*e.g.*, treacle, golden syrup, vinegar made from converted raw grain), and foods, the principal basis of which is malt or yeast, or into which glycerine enters in any considerable proportion.

Cf. para. 131, *sup.*

145. In these cases, also, we think that the tests applied, alike to the ingredients and to the finished product, should be delicate, and should enable minute quantities of arsenic, if present, to be detected and estimated so that the manufacturer may know the degree of success which he is attaining in excluding arsenic. Records should be kept of the results of the system of testing adopted.

PART VI.

PRESENT MEANS OF OFFICIAL CONTROL OVER PURITY OF FOOD, IN RELATION TO ARSENIC.

146. Under this heading we summarise the effect of the evidence which we have obtained from various witnesses regarding the means of official control over the purity of food which is at present available :—

(*a*) to prevent ingredients of food which are contaminated by arsenic from being used by the food manufacturer.

(*b*) to prevent finished food products contaminated by arsenic from being sold to the public.

Control over the Manufacture of Food or of Food Ingredients.

147. The existing machinery of public health administration provides little if any system of official control over the proceedings of manufacturers of food or of food ingredients. The fact that on certain premises food or its ingredients are made or prepared, does not of itself entitle the officials of County, Borough, Urban or Rural District Councils, who are charged with the local administration of the Acts relating to public health and sale of food, to enter the premises, to require information concerning processes of food manufacture, or to demand samples for analysis, with a view of ascertaining if risk of contamination by any deleterious substance arises and whether suitable precautions are taken. Similarly, an individual or a company who starts the manufacture of some new composition of food, sold under a "fancy" name, is under no obligation to satisfy the local or any other public authority that the composition and its ingredients are wholesome. There are a few instances in which local authorities possess power of control at particular places where food is manufactured: for example, the sanitary authorities of certain districts have obtained powers, under local Acts, to supervise the conditions of manufacture of ice-cream. Broadly speaking, however, the control which can be exercised becomes availale only after the manufacture of the food is completed, and it is on sale to the public.

Tattersall, 296-310.
Niven, 796-803.
Hope, 1012-34.
Veech, 9224-9, 9246-51.
H. Smith, 10,931-63.
Lithiby, 11,508-12, 11,530, 11,548-88.
Allen, 12,046-7.

148. Officials of Government departments possess and exercise powers of entry into factories for specified purposes (as for example, under Factory Act, with reference to conditions affecting the health and safety of the persons employed) and their powers, in certain instances, enable them to institute inquiries into methods of food manufacture. Where margarine and margarine cheese are made, officers of the Board of Agriculture have the right to inspect any process of manufacture, take samples, and examine books showing the destination of margarine or margarine cheese sent out from the factory. With regard to articles subject to duty, various powers of inspection and sampling are conferred upon revenue officers. At breweries, Officers of Excise are in position to ascertain generally what materials are used in the preparation of beer, and, practically speaking, they are there able to take samples of any ingredient for examination in the Government Laboratory. Samples of substances intended for use as additions to beer—such as preservatives—are required to be submitted to the Board of Inland Revenue, whose sanction must be obtained before they can be used. Although similar sanction is not required before particular substances can be used in brewing, yet, by the Customs and Revenue Act of 1888 the Commissioners of the Treasury have power to prohibit, by issue of an

Sale of Food and Drugs Act, 1899, S. 7.

Primrose, 6526-6708.
Spencer, 5 56, 5433-7.
Deakin, 3899.

order published in the London Gazette, the use in the manufacture or preparation for sale of any article of excise, of any "substance or liquor of a noxious or detrimental nature," or which "being a chemical or artificial extract or product, may affect prejudicially the interests of the Revenue," and any person using the substance thus prohibited in the manufacture or preparation for sale of any article specified in the published notice is subject to penalty.

149. The main object with which these various powers have been granted to, and have been exercised by the Board of Inland Revenue, has, of course, been the protection of the Revenue. In our first Report, we considered the question of utilising the system of Government inspection which exists at breweries, to obtain safeguards against the introduction of arsenic into beer by way of its ingredients. Evidence which we received from the Chairman of the Board of Inland Revenue in April of this year, summarises the action which the Board have been able to take in this direction since our first Report was issued. We have referred above (par. 46), to the appointment of the Departmental Committee to advise with regard to official methods of testing for arsenic, and to their report. In October, 1901, the power of prohibition under the Revenue Act of 1888, which previously had been applied only to saccharin, objected to for revenue reasons, was exercised in respect of glucose and "invert" sugar containing arsenic, which were prohibited by Treasury Order. Since the issue of this Order, the Board of Inland Revenue have caused numerous samples of brewing ingredients to be taken at breweries by their officers—not only glucose and "invert" sugar to be examined with reference to the above prohibition, but also malt, caramel, hops and other substances. These, as well as a number of brewer's worts, have been tested in the Government Laboratory. Samples of brewing sugars collected at factories in this country have also been examined in the Government Laboratory, as well as imported brewing sugars which had been obtained by brewers without guarantees of their freedom from arsenic. Substances submitted for sanction as additions to beer, have been examined for arsenic, and in certain cases where beer "regenerators" and yeast foods have been found arsenical the manufacturer has either been cautioned or sanction to the use of the substance has been withheld. Brewers also have been warned in certain instances where their malt or other ingredients taken at the brewery was found to be seriously contaminated by arsenic.

First Report, paras. 26–34.

Primrose, 11,844-967.

150. We understand that the Board of Inland Revenue have been able to utilise their official staff for the above purposes without detriment to their principal revenue duties, and that it has been found practicable at the Government Laboratory to examine samples of brewing materials to the considerable extent indicated in the evidence to which we have referred. We are of opinion that the action thus taken has been most valuable and that it should be continued in the future. It has been represented to us that in ordinary circumstances a general test of the brewers' precautions, and one which is administratively convenient, consists in applying tests for arsenic to samples of wort obtained by the Revenue Officers, and this appears to us a useful procedure for routine purposes.

Salamon, 9991-3.
Chapman, 10,317-48.

Control over Food on Sale.

151. Sale of Food and Drugs Acts:—Under present conditions the main system of official control against the introduction of deleterious substances into food consists in the application of the Sale of Food and Drugs Acts, which empower officers of local authorities to obtain samples of foods and of food ingredients in a prescribed manner from places where they are on sale, for the purpose of analysis by the public analyst. Offences against the Acts may be dealt with by proceedings instituted by the local authority under Section 3 or Section 6 of the Sale of Food and Drugs Act of 1875. Section 3

imposes a penalty on any person who "mixes, colours, stains, or powders any article of food with any ingredient or so as to render the article injurious to health, with intent that the same may be sold in that state." Section 6 imposes a penalty on the person who "sells to the prejudice of the purchaser any article of food or any drug which is not of the nature, substance and quality of the article demanded by such purchaser," subject to certain specified reservations.

Prosecutions under the first of these sections, in respect of additions to food which are or which may be held to be deleterious are comparatively seldom instituted by authorities under the Acts. The Section would cover, no doubt, cases where a substance well known to be poisonous is purposely added to food, for example if red lead was mixed with cayenne pepper, or Scheele's green used to colour sweets. But authorities administering the Sale of Food and Drugs Acts have found that the circumstances under which this section can be utilised to deal with articles which contain ingredients liable to be harmful seldom arise, and in practice nearly all prosecutions are taken under Section 6 of the Act. Prosecutions in respect of preservatives in milk for example are usually instituted under this section for the sale of an article—milk plus preservative—not of the nature, substance and quality demanded by the purchaser.

Niven, 579–590.
Hope, 1171, 1193–1204.
Estcourt, 3955–8.
Sergeant, 4128.

Even in the case of foods contaminated by arsenic in such ways as we have described in Part IV. of this report, it would appear that a prosecution would in most instances have greater chance of success if taken under section 6, and this view was held almost without exception by the local authorities which decided to institute prosecutions with regard to arsenical beer in consequence of the 1900 epidemic.

152. The evidence which we have received from various official witnesses shows that the Sale of Food and Drugs Acts, as at present interpreted and administered, are unsatisfactory for the purpose of protecting the consumer against arsenic or other deleterious substances in food, mainly for the following reasons:—

153. (*a*) *Prosecution of Retailer.*—The offence created by Section 6 of the Act of 1875 lies in the sale of the deleterious or adulterated article. Save for certain small exceptions, (as where samples have been taken in transit to the retailer, with the latter's consent) prosecutions must be directed, not against the manufacturer, importer, or middleman, but against the retailer, who, in the great majority of such cases as we are considering, has had nothing to do with the contamination, and has seldom been in a position to ascertain that it exists. It is true that if the retailer is prosecuted, the case may be defended on his behalf by the manufacturer, but none the less the retailer is liable to be prejudiced in the eyes of his customers, and our evidence shows that local authorities are often reluctant to institute proceedings in these circumstances against a person whom they do not regard as himself culpable. The retailer can protect himself by obtaining a warranty, which will be a bar to his conviction in the case of foods which he can prove that he sold in the same state as when purchased, and where the case against the retailer fails through a successful defence of warranty, it is open to the local authority to take action subsequently against the warrantor. But the conditions which have to be complied with under the statutes, in order that the prosecution of the warrantor may be successful, are somewhat numerous and exacting. Prosecution would fail, for example, if the proceedings were taken more than six months after the warranty was given. The warrantor may claim that he is prejudiced by the absence of a control sample available for him. When he is proceeded against the whole case has to be gone into afresh, with the possibility of inconsistent conclusions. Moreover, the warrantor may make a sufficient defence if he can show that at the time of giving the warranty "he had reason to believe that the statements contained therein were true." These and other considerations in practice frequently deter local authorities from pursuing a case where the

Vol. I, Index, "Food and Drugs Acts.
Vol. II. *do.*

Hope, 977, 1204.
Allen, 12,013-4.

Sale of Food and Drugs Act, 1875, s. 25–27; 1899, s. 20, &c.
Tattersall, 329–30.
Lithiby, 11,618-22.
Allen, 12,062, 12,017.

retailer has successfully set up the defence of warranty, and in consequence the person or firm responsible for the contamination is not reached at all.

Vol. I. Index, "Food and Drugs Acts." *Vol. II.* ,, do.

154. *(b) Want of knowledge as to foods liable to contain deleterious substances:*—The Acts are generally regarded as intended to deal with certain well-known customs of fraudulent adulteration—for example, the dilution of milk or spirits with water, the abstraction of cream from milk, selling mixtures of coffee and chicory as coffee, and the like—rather than with risks to health from deleterious substances. The officers of local authorities who collect samples in the main direct their attention to cases of this sort. They have as a rule very little expert advice or direction which enables them to know what samples should be obtained as a control against substances injurious to health, or in what number these should be taken.

H. Smith, 10,929.
Lithiby, 11,519.
Allen, 12,008.

The Medical Officer of Health is seldom in position to afford advice of this kind; moreover, many authorities under the Sale of Food and Drugs Acts are County Councils which have not appointed a Medical Officer of Health. Public Analysts may possess special knowledge regarding methods of preparation of food stuffs, but it is no part of their official duty to advise as to the nature and number of samples which should be taken, and commonly their authorities do not invite their co-operation on the matter, even when they reside in the districts for which they are appointed analysts. As a rule, public analysts receive samples in order that they may pronounce upon their "genuineness" or otherwise, knowing nothing of the local circumstances which led to their being taken, of their origin, or of the reasons for sending them. The term "genuine" in this sense means that the analyst has not detected such objectionable substances as he has considered it necessary to look for in the sample submitted to him. Obviously the value of the statement that a sample is "genuine" depends upon the extent to which the analyst has means of knowing what are the objectionable substances which it is liable to contain. In present circumstances he has not sufficient information on this point. Different analysts may thus pronounce upon the genuineness of identical samples on widely different data.

Tattersall, 28.
Estcourt, 4114.
Hehner, 8008–12.
C. Brown, 6931.
Allen, 12,005.

Hope, 925–6, 970–1.
Lithiby, 11,506, 11,634-40.
Allen, 12,006-8.

155. The extent to which the Sale of Food and Drugs Acts are utilised by authorities charged with their administration varies within wide limits. These variations are obvious when the ratios which total samples taken under the Acts bear to the population is studied in different districts, and are still more striking when the corresponding ratios for particular foods are contrasted. Thus in particular instances no samples of beer were taken by local authorities under the Sale of Food and Drugs Acts even after the discovery of the cause of the epidemic of 1900. And when in February, 1902, we instituted inquiries at Halifax, where arsenical beer had lately been producing illness, we learnt that in that borough no sample of beer had been taken for public analysis for twelve months, and that similarly no beer samples had been taken during the same period in the neighbouring borough of Huddersfield.

H. Smith, 8826-30.
Neech, 9193-7.

Lithiby, 11,498-506.
11,513-9, 11,537, 11,643-9.

156. The obligations in the matter of directing and supervising the work of local authorities, which have been imposed upon the Local Government Board under the Sale of Food and Drugs Acts, in general are of a limited character, although they have been enlarged in some respects by the Sale of Food and Drugs Acts of 1899, which enables the Board to take action in certain directions where a local authority fails to exercise its powers under the Acts. Hitherto the principal work of the Local Government Board in relation to the Sale of Food and Drugs Acts has consisted in sanctioning the appointment of public analysts, receiving annually copies of the quarterly reports made by public analysts to their local authorities, abstracting and tabulating these quarterly reports for the purposes of the Board's Annual Reports, and exerting pressure on authorities in cases where returns show that the

Lithiby, 11,630-1.
Allen, 12,010-1.

total number of samples taken under the Acts has been exceptionally small in proportion to the population of the districts concerned. When the cause of the 1900 epidemic was discovered, the Board, by circular, advised local authorities to collect samples of beer and certain other foods in order that these might be examined for arsenic. No statutory duty has, however, been imposed on the Local Government Board under the Sale of Food and Drugs Acts to advise local authorities as regards particular food substances which should receive attention either on account of particular methods of adulteration or of risk to health, and it has not hitherto been the Board's custom to take any systematic action in this direction.

157. (*c*) *Absence of official "standards."*—The application of the Sale of Food and Drugs Acts to prevention of contamination of foods by deleterious substances is materially hindered by want of an official authority with the duty of dealing with the various medical, chemical, and technical questions involved. At present there is no public authority to define, for example, impurities or adulterations which should be specifically looked for in course of examination of particular foods submitted for analysis under these Acts, or to lay down official "standards" for the use of all concerned, respecting the nature and extent of impurity or adulteration in a given food which, without question, should render its vendor or warrantor liable to proceedings under the Acts. Hence, when cases come before magistrates much conflicting expert evidence is often brought forward, and costly litigation, involving appeals to the High Court, frequently arises—conditions which may bear hardly on the person prosecuted, and which deter local authorities from taking action in the case of any unaccustomed form of adulteration or contamination.

Allen, 12,020-33, 12,013, 12,061.
C. Brown, Appx. 15.

158. In the case of foods liable to contain arsenic these drawbacks have been fully illustrated. Public Analysts, Medical Officers of Health, manufacturers, and other witnesses, have been practically unanimous in urging on the Commission the need for such official standards, and we consider their imposition essential to the successful use of the Sale of Food and Drugs Acts to prevent arsenical contamination.

Vol. I, Index, "Official Control."
Hehner, 10,155-7.
Chapman, 10,290.
Allen 12,020.

159. Public Health Acts:—Some further means of control over the purity of finished foods is afforded by the power given to the Medical Officer of Health or Inspector of Nuisances in districts where Part III. of the Public Health Acts Amendment Act, 1890, has been adopted, to seize any article intended for human food which he has reason to believe is unwholesome or unfit for the food of man, with a view to its condemnation by a justice. In the opinion of witnesses whom we have examined on the point, these powers of seizure (which are mainly utilised in connection with rapidly perishable articles such as meat, fish, and vegetables) are hardly capable of satisfactory application where the proof that the article is deleterious is dependent on chemical analysis—particularly as the official would have no power to lay an embargo on the sale of a suspected article pending its chemical examination.

Niven, 741–8.
Hope, 975–6.
Reid, 1890–3.
Estcourt, 4046.
Lithiby 11,608-15.

Our evidence shows that the officials concerned did not consider these or other powers enabled them to secure the official seizure of arsenical beer in breweries after the cause of the 1900 epidemic was traced. The importance of this matter is illustrated by the fact that (notwithstanding the commendable promptness with which many of the implicated breweries acted on the discovery of the cause of the epidemic), beer contaminated by Bostock brewing sugars was in some cases sold many weeks after their dangerous character had become generally recognised. On inquiry in May, 1901, we ascertained that no action was taken by the local authority in the district in which the works of Messrs. Bostock & Co. were situated to seize or otherwise deal with the large quantity of contaminated glucose, "invert" sugar, and table syrup stored at these works after their poisonous nature had been discovered.

Estcourt, 4085-6
Allen, 12,035.

Williamson, 7324.
H. Smith, 10,971-82.

PART VII.

RECOMMENDATIONS AS TO IMPROVEMENTS IN OFFICIAL CONTROL OVER THE PURITY OF FOOD.

160. We consider that the control which can at present be exercised in the restricted form already indicated (Part VI) is unsatisfactory when applied to the prevention of risk of contamination of foods by arsenic ; and further, that our evidence shows that serious defects exist in the machinery available to safeguard the public against the introduction of poisonous, deleterious, or valueless substances in general into articles of food. In view of the greater importance which administrative questions relative to the purity of food are rightly coming to assume (as evidenced by the number of occasions on which in recent years it has been necessary for Parliament or Goverment Departments to appoint Committees of Inquiry) we have thought it proper, in making our recommendations, to have regard to the broader issues concerned, and not merely to arsenic.

Cf. First Report, para. 33.

161. In particular, we have taken account of the inquiries of the Select Committee of the House of Commons which reported in 1896 on the Adulteration of Food Products, and of the Departmental Committee which reported in 1901 on Preservatives and Colouring Matters in Food, and to the recommendations for amendments in legislation and administration which have been made by these Committees.

162. Our conclusions on this part of our inquiry are as follows :—

(A) Necessity for more extended administration by the Local Government Board.

Cf. paras. 147-156, above.

163. There is need for efficient central administration in order that the system of control provided by the Sale of Food and Drugs Acts may be properly utilised, not only to protect the consumer against fraudulent adulteration, but also in the interests of the public health. The work of local authorities under these Acts should be co-ordinated : these authorities should have open to them better means of knowing whether a given food substance is liable to contamination or may become deleterious to health as a result of its method of manufacture or preparation for sale, and should have advice tendered to them as to the way in which the Acts may best be applied to secure the purity of food. Knowledge in the above sense is particularly needed with regard to new preparations of food, and to the large and increasing number and variety of food products made up in tins, packets and bottles ready for sale by the retailer. Many of these substances are now sold under fancy names without any indication of the ingredients which they contain, or of the substances used in their manufacture, and in present circumstances hardly any official control is exercised over the purity of these preparations. Even if samples of such foods are taken under the Sale of Food and Drugs Act, which is seldom the case, the analyst as a rule has no means of knowing whether particular deleterious matters should be specially looked for.

Hope, 1135-45, 1186-92.
Delépine, 5319.
C. Brown, Appx. 15.

164. We have considered the suggestion of some witnesses that many of the present difficulties may be met by local public health authorities, by giving to their officers the duty of making inquiries as to conditions of food manufacture, either generally, in all places where food is prepared, or in particular instances where there is reason to believe that potentially dangerous ingredients, such as glucose or sulphuric acid, are used ; and that for this purpose these officers should be empowered to enter premises, inspect warranties and contracts, take samples, and the

like. It appears to us, however, that there are very serious objections to making the question one of purely local power and responsibility, even if the officers of the larger local authorities, County Councils and County Boroughs, were alone concerned. Many foods consumed within a county area, and which the county authority would need to deal with, would be manufactured outside that area, and powers given to local officials to inspect or make inquiries at food factories in any part of the kingdom would be practically unworkable, while these officers would be unable to obtain information regarding manufactured foods which are imported from abroad. Existing officers of county authorities in many instances would not be available for this additional duty, or would not possess the scientific and technical knowledge necessary for the satisfactory use of the powers of inspection. Moreover, our evidence shows that food manufacturers would be likely to resent inquiries by local officials as to the ingredients and processes which they employ; and they would properly object to inspection by officials of several different local authorities.

Garton, 6225.
Lyle, 11,144-7

165. An alternative proposal is that the central public health authority, the Local Government Board, which at present is the Government Department mainly charged with supervising the administration of the Sale of Food and Drugs Acts, should undertake further duties of supervision and watchfulness in relation to the purity of foods and the administration of the Acts bearing on the subject.

At present the Local Government Board do not employ expert advice to guide them in dealing with the reports of public analysts which are sent to them, and therefore cannot make full use of their opportunities as an intelligence department in reference to questions arising under the Sale of Food and Drugs Acts. For the same reason the Board are unable to direct or advise local authorities as to the nature of samples which should be collected under the Sale of Food and Drugs Acts, or to secure that public analysts work in the same direction when pronouncing on the "genuineness" of such samples. In this connection it is instructive to note that, as a result of recent communications by the Board of Agriculture to local authorities, the check of public analysis on the adulteration of milk and butter has been largely increased throughout the country.

166. We are of opinion that the Local Government Board should take action in these matters, and that for this purpose they should have the advice of a special officer with suitable scientific knowledge, who should be in relation with the Government Laboratory, and be able to institute necessary chemical inquiries, and in other ways (for instance, where physiological investigations are necessary) have adequate laboratory assistance. In this way full and authoritative investigation could be made where new risks to health are suspected, or where new colouring matters, preservatives, or other chemical additions to food are introduced. Such officer, or his assistants, should have the duty not only of collecting information from public analysts and other local officers, and of advising how work under the Sale of Food and Drugs Acts may be run on satisfactory lines; but also of making inspections where necessary and of instituting inquiries as to conditions of manufacture of food in this country. He should also obtain all information possible regarding the manufacture of food stuffs imported from abroad, and should report annually. Under the improved conditions which we are considering, the Local Government Board should for food purposes be in touch with, and on occasion should obtain the co-operation of other departments of Government which would be able to render assistance in special directions—for instance, the Board of Inland Revenue in the case of articles subject to duty of excise, the Board of Customs in the case of imported foods, and the Patent Office in the case of patented processes of food preparation.

167. By these means we think that the Local Government Board would not only be able to advise and direct the work of local authorities

in the matter of securing the greater purity of food supplies in a way not hitherto attempted but also they would be able to make suggestions by way of reports, which will be of material assistance to the manufacturer who is anxious to secure the purity of his products, and to others concerned. The Board would further be able to secure that wider use is made of special work undertaken by public analysts in matters relating to food. It would seem more satisfactory that these officers should report annually, and if needed should also make special reports on particular subjects, than that the present system of routine quarterly reports should be continued.

Garton, 6221-5.
Lyle, 11,060-3, 11,141-7.
Howell, 11,237-42.
Walker, 11,336-8.
Lithiby, 11,602-5.
Legge, 11,838-43.

168. We are satisfied from the evidence which we have received that many food manufacturers, some of whom would entertain considerable objection to inquiries by officers of local authorities with regard to the precautions taken to secure the purity of food, would be willing to afford facilities to a responsible officer of a Government Department charged with undertaking inquiries for the same purpose. Moreover, if it were necessary to seek powers from Parliament in order to give official right to enter all food factories, it would be more consistent with the general trend of modern legislation to grant such powers to the officers of a Government Department than to officers of local authorities.

B.—Necessity for Official Standards:—Board of Reference.

"Standards" for purposes of the Sale of Food and Drugs Acts.

Cf. paras. 157-8, above.

169. We are of opinion that official standards must be prescribed if the Sale of Food and Drugs Acts are to be satisfactorily applied to control the purity of food. We term these "standards for the purpose of the Sale of Food and Drugs Acts," rather than "standards of purity," and in view of the considerations with regard to arsenic set out above in paragraphs 39-41, we think it important to insist upon the obvious distinction which has to be made in this respect. The standards we are considering are not models of purity for the manufacturers to aim at. Their object is to afford satisfactory means of judging whether in a given substance there has been substantial failure to secure purity, a failure which, on official authority, is held to call for the imposition of penalty.

For example, in relation to deleterious substances, where the offence lies in selling something not of the nature, substance and quality demanded by the purchaser, the "standard" would take the form of a definition of the minimum degree of purity which can be accepted as fulfilling the purchaser's demand—no more than so much boracic acid, no formalin, not more than so much arsenic, or whatever is necessary in the interests of the consumer to safeguard the particular food.

170. We consider that the Local Government Board (under advice as indicated in this Report), should be the authority to prescribe, and from time to time to vary, standards for the purposes of the Sale of Food and Drugs Acts.* Obviously, account would need be taken of sundry medical, physiological, chemical, and administrative questions in fixing such standards. It is necessary that these considerations should be properly balanced, and that manufacturers should be fairly dealt with. The means by which these requirements can be fulfilled were considered by the two Committees to which we have above referred. The Committee on Food Products Adulteration, which was mainly concerned with questions of preventing adulteration and impoverishment of food, and more recently, the Committee on Preservatives and

* Or the Board of Agriculture, where matters affecting the general interest of agriculture are concerned. Special duties in such cases have been imposed on the Board of Agriculture by the Sale of Food and Drugs Act, 1899; and certain standards have already been prescribed by this Board, in accordance with the provisions of the Act, and after inquiry by a Departmental Committee, in respect of milk and cream.

Colouring Matters in Food, alike came to the conclusion that food standards in certain instances were essential to efficient administration. Both Committees realised the impossibility of satisfactory standards being fixed by the central authority in the absence of full preliminary inquiry, and they recommended the establishment of a Board (Court, Permanent Commission or Standing Committee) of Reference, which should consist of a small number of scientific men, nominated by the Crown or departmentally, as the authority to advise on points arising in connection with the Sale of Food and Drugs Acts and requiring special expert consideration, and to prescribe the standards which should be fixed for the purposes of those Acts.

171. We are of opinion that if a Government department, the Local Government Board (or Board of Agriculture in cases where the general interests of agriculture are concerned) is to impose standards for the purposes of the Sale of Food and Drugs Acts, it is essential that its action should be based upon the advice of a scientific body of this nature. We do not think that the proposed Board of Reference should be an administrative body. It should be a consultative Board, available on the application of the Government department concerned, to pronounce on specific points which are specially referred to them The findings of the Board of Reference in relation to standards and other matters should be carried into effect by order of the department concerned, whose action would be subject to the control of Parliament. *Lithiby, 11,542-6.*

172. It has been objected that where questions related to a particular trade are concerned, manufacturers or technical experts in that trade ought to be represented on the Board of Reference, and that in view of the great variety of foods concerned, the Board of Reference would consequently have to be large and unwieldy. We do not think that there is much force in this objection, and we consider it would be more satisfactory for the Board of Reference to secure all technical information necessary in a given case by means of evidence and inquiry

"Standards" for Ingredients and substances used in the preparation of food.

173. Standards are also demanded in the interests of the public health, and of the manufacturer, in respect of particular ingredients of food, or substances used in the preparation of food. The importance of official standards for these substances (for example, standards as to arsenic in sulphuric acid, glucose, malt, or colouring matters, fixed with regard to the degree of purity attainable in the substances themselves, irrespective of the extent to which they may be used in the manufacture of particular articles of food) has been fully illustrated by our inquiry, and we think that such standards should also be prescribed in the manner above indicated. *Cf.* para. 136, above.

174. The "standards" in this case would define substances, which, on account of their own deleterious properties, or of contamination by particular deleterious impurities, should be considered as inadmissible in the preparation of any article of food.

175. Witnesses have recommended in several instances, not only that standards of this kind should be prescribed, but also that manufacturers of food or food ingredients in this country should be prohibited under penalty from using substances which transgress these standards. At present, as we have stated above, there exists, in general, no system of control by which such official prohibitions could be enforced at places where food and its ingredients are prepared. And it is probable that considerable difficulties would arise in legislation and administration to secure adequate official inspection for this purpose. It is obvious that the main object of the inspection by an officer of the Local Government Board which we have advocated should be rather to obtain general information as to the nature of processes carried on and as to the sufficiency of the system of precaution adopted to secure pure ingredients, *Salamon, 10,009. H. Smith, 10,923-38.* Delépine, 5319.

than to attempt systematic supervision over the everyday proceedings of the manufacturer with a view to detecting offences which would render him subject to legal proceedings.

176. However this may be, there should be no difficulty in arriving at standards which will be of assistance to the manufacturer in preparing or in ordering substances used in food preparation, and it may be expected that ordinarily a standard officially recommended after careful inquiry (for example, as to arsenic in glucose or in sulphuric acid used for food purposes) would be adopted by manufacturers and would be required by wholesale purchasers in their own interests and apart from penalty; more especially if, under the improved conditions of administration above considered, the control over deleterious substances afforded by public analysis of the finished product was strengthened, and the manufacturer was aware that official inquiry might be made as to his precautions.

177. The control over arsenical contamination recently exercised in breweries by the action of the Board of Inland Revenue (para. 149), and which, in our opinion, should be continued, will facilitate the general adoption of official standards which may in future be prescribed in respect of arsenic in beer ingredients.

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178. We would briefly indicate the application of the recommendation of the foregoing paragraphs 163 to 177 to the case of arsenic in food. Under the above scheme, it would form part of the duty of the expert officer appointed by the Local Government Board for food purposes to advise the Board as to risks from arsenic in particular foods and materials used in the preparation of foods, as to risks newly discovered (particularly in regard of new preparations of food and new ingredients and methods), and as to the extent and nature of the control, central and local, which is necessary to guard against these risks. For these purposes he would utilise various sources of information available to him in course of his official work—information obtained for example, from the Government Laboratory and other Government Departments; from Medical Officers of Health and Public Analysts; from the Board's own inquiries of manufacturers; and from chemical work conducted in the Government Laboratory or otherwise for the Board. In the case of beer or of other articles subject to duty, he would keep himself informed of the system of control adopted by the Board of Inland Revenue.

179. The Local Government Board thus advised would be in position to deal with risks of arsenical contamination as part of their administration of the Sale of Food and Drugs Acts, by (*a*) Publication of special reports, and warning manufacturers, by circular or otherwise, where precautions appeared inadequate. (*b*) Prescribing by Order, on the authority of the Board of Reference, the quantities of arsenic (ascertained by particular tests) which if exceeded in given classes of food should entail penalty under the Sale of Food and Drugs Acts. (*c*) Securing by advice or instructions to Local Authorities, Analysts, and other executive officers, that the check of public analysis is properly and sufficiently applied to foods liable to arsenical contamination. (*d*) Defining, on the authority of the Board of Reference, standards in respect of arsenic in ingredients of food, and in substances used in the preparation of food, for adoption by the manufacturer and user of such substances.

C.—Responsibility of Manufacturer or Intermediate Vendor under the Sale of Food and Drugs Acts.

180. The nature of the amendment of the Sale of Food and Drugs Acts which we consider necessary for this purpose may be stated as follows:—

Cf. para. 153, above.

If, in a prosecution instituted under the Sale of Food and Drugs Acts, it is alleged by defendant A that the article was sold in the

condition in which it was supplied to him by B (*e.g.*, the manufacturer, importer, or giver of warranty); or that the contamination is due to an ingredient supplied by C; it should be possible for A to attach B (or C as the case may be) to the prosecution. The same principle should apply to the person thus associated in the defence, if he in his turn alleges that a third party is responsible, by breach of warranty or otherwise, for the adulteration or contamination of the final product.

We think that if the whole of the facts are thus brought before the Court at one hearing, responsibility can be properly brought home to the real offender in a way not at present possible. In making this recommendation we have had in mind the precedents which are afforded by Section 12 of the Truck Act, 1887, and by Section 141 of the Factory and Workshop Act, 1901.

D.—Powers of Local Authorities to prevent the Sale of Suspected Foods pending Analysis.

181. We think that the powers which Medical Officers of Health at present possess under the Public Health Acts to obtain the condemnation of unsound or unwholesome articles of food should be extended. Where the Medical Officer of Health has good reason for believing that particular articles of food or ingredients of food have caused, or are liable to cause, injury to health, but is of opinion that analysis of samples is necessary before the facts can be fully established, powers should be given to lay an embargo on the sale of the suspected articles or on the use of the suspected ingredients, pending their official examination. The grant of these powers should be accompanied by the requirement that a Justice's order should be obtained, or by other provisions which are adequate to prevent their being used unnecessarily or improperly.

Cf. para. 159, above.

PART VIII.

PROPORTIONS OF ARSENIC IN FOOD WHICH SHOULD CONSTITUTE AN OFFENCE UNDER THE SALE OF FOOD AND DRUGS ACTS.

182. Pending the establishment of official standards in respect of arsenic under the Sale of Food and Drugs Acts, the evidence we have received fully justifies us in pronouncing certain quantities of arsenic in beer and in other foods as liable to be deleterious, and at the same time capable of exclusion, with comparative ease, by the careful manufacturer. In our view it would be entirely proper that penalties should be imposed under the Sale of Food and Drugs Acts upon any vendor of beer or any other liquid food, or of any liquid entering into the composition of food, if that liquid is shown by an adequate test to contain $\frac{1}{100}$th of a grain or more of arsenic in the gallon; and with regard to solid food—no matter whether it is habitually consumed in large or in small quantities, or whether it is taken by itself (like golden syrup) or mixed with water or other substances (like chicory or "carnos")—if the substance is shown by an adequate test to contain $\frac{1}{100}$th grain of arsenic or more in the pound.

All which we humbly submit for your Majesty's gracious consideration.

(Signed) KELVIN, *Chairman.*

W. HART DYKE.

W. S. CHURCH.

T. E. THORPE.

H. COSMO BONSOR.

B. A. WHITELEGGE.

G. S. BUCHANAN, *Secretary,*

6th November 1903.

Memorandum by Dr. Thorpe.

I concur in the Report, except as regards one portion of the Section relating to official standards and the suggested Board of Reference. Part VII., B. pp. 46-7.

Although the whole question of Official Standards of "food-purity" or genuineness is surrounded with difficulties, many authorities doubting the wisdom and expediency of setting them up, I incline to the opinion that the successful working of the Food and Drugs Acts requires them to be prescribed.

Such official standards have usually regard to a deficiency, to the prejudice of the purchaser, in some normal constituent or constituents. Now before any official standard or limits, in any particular instance, can be prescribed, it is necessary to ascertain how much of the constituents the article ought normally to contain, and then, having regard to all the conditions of supply and distribution, to fix upon a limit or standard which is reasonable and practicable.

To arrive at a just and satisfactory compromise—for the great majority of such food standards are and necessarily must be of the nature of compromises—is frequently a very difficult and intricate problem and needs for its solution knowledge and experience, not only of the composition of the substance, the extent to which that composition may legitimately vary, and the causes and frequency of such variation, but also of the actual conditions of its production and distribution.

For example, to determine what deficiency in the amount of fat, or of non-fatty solids in milk, or what deficiency in the amount of the characteristic constituents of butter, or what proportion of water in butter, shall, for the purposes of the Sale of Food and Drugs Acts, raise a presumption that the milk or butter is not genuine, may appear a very simple problem to anyone who has not been actually engaged in the attempt to solve it. In reality when due regard is had to the various and complex considerations which affect the matter it is by no means simple. Experience has shown that to solve it adequately and in a manner calculated to secure public confidence, its consideration is best entrusted to persons of special knowledge and experience of the article for which a "standard" is required.

In the Food and Drugs Act of 1899 the Board of Agriculture took powers to make regulations, after such inquiry as they may deem necessary, for determining when a presumption shall be raised that milk, cream, butter, or cheese are not genuine. In cases of the kind the Board has appointed an *ad hoc* Committee to consider in the first place whether any regulations at all were desirable, and if so, to determine the principles on which the regulations should be based, and the Board has taken care in constituting the Committee that every interest and every class of consideration should be adequately regarded.

I venture to think, therefore, that instead of creating a permanent Committee consisting of a small number of scientific men, as the authority to prescribe the standards which should be fixed for the purposes of the Sale of Food and Drugs Acts, it would be preferable to follow the procedure of the Board of Agriculture and to entrust the consideration of the propriety of fixing a standard, or standards in the case of particular groups of allied substances, to specially constituted Committees in which manufacturers and technical experts in the trade concerned were represented. Considering the very large and legitimate commercial interests involved, I am of opinion that no other course would be satisfactory.

There is, however, a class of questions connected with public health which have no relation to the natural variations in quality of

articles of food, and which might properly be referred to such a body as is contemplated in the Report. These matters are intended to be dealt with under Section 3 of the 1875 Act, which is concerned with the adulteration of articles of food with substances injurious to health. The substances so added are not, as a rule, naturally present in food, and are not of the nature of food, *e.g.*, mineral colouring matters, so-called aniline dyes, antiseptics, &c.

The Departmental Committee appointed by the Local Government Board in 1899, to inquire into the use of preservatives and colouring matters in the preservation and colouring of food, were of opinion that a body such as is contemplated would prove most useful with regard to the subject of food preservatives and colouring matters in food. This body in their opinion "should not be too large, but should embrace at least a chemist, a bacteriologist, a pharmacologist, a physician, a physiologist, and a representative of the Public Health Service." A body so constituted would, of course, be perfectly competent to deal with such questions as the permissible limit of arsenic in food, and whether the use of preservatives and colouring matters in food is injurious to health; but it is open to doubt whether it would be equally competent to deal with such questions as what proportion of husk in ground pepper, or what proportion of starch-glucose in golden syrup, or what proportion of beef-stearin in lard, shall raise a presumption that these articles are not of the nature, substance, and quality demanded by the purchaser.

T. E. THORPE.

14*th November*, 1903.

ROYAL COMMISSION

ON

ARSENICAL POISONING

ARISING FROM THE CONSUMPTION OF BEER AND OTHER ARTICLES OF FOOD OR DRINK.

MINUTES OF EVIDENCE AND APPENDICES.

VOL. I.—Evidence received in 1901,

TOGETHER WITH

Appendices 1 to 15, and Index.

(BEING PART II. OF THE FIRST REPORT OF THE COMMISSION).

Presented to both Houses of Parliament by Command of His Majesty.



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1903.

[Cd. 1845.]

FIRST REPORT—Part II.

MINUTES OF EVIDENCE received by the Royal Commission appointed on 4th February 1901, to ascertain with respect to England and Wales:

(1) The amount of recent exceptional sickness and death attributable to poisoning by arsenic;

(2) Whether such exceptional sickness and death have been due to arsenic in beer or in other articles of food or drink, and, if so,

(*a*) to what extent;

(*b*) by what ingredients or in what manner the arsenic was conveyed; and

(*c*) in what way any such ingredients became arsenicated, and

(3) If it be found that exceptional sickness and death have been due to arsenic in beer or in other articles of food or drink, by what safeguards the introduction of arsenic therein can be prevented,

together with APPENDICES and INDEX.

4576. 1500.—Wt. 28817.—11/03. Wy. & S.

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MINUTES OF EVIDENCE

TAKEN BEFORE THE

ROYAL COMMISSION

ON

ARSENICAL POISONING.

FIRST DAY.

AT WESTMINSTER PALACE HOTEL.

Friday, 22nd February, 1901.

PRESENT:

The Right Hon. LORD KELVIN (in the Chair).

The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Professor THORPE.
Mr. COSMO BONSOR.
Dr. WHITELEGGE.

Dr. BUCHANAN, *Secretary*.

Mr. CHARLES H. TATTERSALL, called; and Examined.

Mr. C. H. Tattersall. 22 Feb. 1901.

1. (*Chairman.*) You are Medical Officer of Health of the Borough of Salford?—I am.

2. And I believe you have made special inquiries into the recent epidemic of arsenical poisoning attributed to beer, and have sent to the Commission proofs of a report to the Salford Town Council, which you are making along with Professor Delépine on the subject?—I have.

3. Professor Delépine himself will give evidence at a later period to the Commission. As Medical Officer of Health you are responsible for complying with the regulations and orders of the Local Government Board with regard to your office?—I am.

4. I have received, and other members of the Commission have received, an advance proof of the special report which you have made on the epidemic of arsenical poisoning from beer. Perhaps in giving your evidence you would freely use this report, and give the Commission the benefit of what information you can in that way. Perhaps a few questions may be put to you later on, but I think now, instead of putting questions to you, I would ask you to read such portions of this report as you find it convenient to read, and give any additional information that occurs to you?—I will read the report.

5. You will use your own discretion, and omit certain parts that you may not think it necessary to read?—Quite so. The charts which accompany the report are in the possession of the members of the Commission, I think. (*See Appendices Nos.* 1 *&* 2.)

6. (*Sir William Church.*) I suppose the charts refer to the Borough of Salford alone?—Yes. The whole of the information has been collected and arises entirely out of the Salford epidemic.

7. These charts apply only to Salford?—Yes, Salford alone.

"From the accompanying charts it will be seen at once that there was a great rise in the number of deaths from 'alcoholism,' 'peripheral neuritis,' or 'multiple neuritis' in the month of June, 1900, and that this continued to increase, reaching its maximum in the month of November. On the 9th of November, Dr. Cran, Poor Law Medical Officer for the Regent Road District, called and informed me that he had a very large number of cases of peripheral neuritis. His diagnosis had been confirmed by finding that all the sufferers took beer, but he had been surprised to learn that many of the patients had not been excessive drinkers. I obtained samples of beer from public-houses supplied by fourteen different breweries, sent them for analysis, and proceeded to make inquiries into the cases of which Dr. Cran had given me a list. Each case was visited and careful inquiries made from the patients, and the results confirmed by neighbours and others. It was soon ascertained that the sufferers were all beer drinkers, and several of them were employees of a local brewery. Further inquiries into the health of the employees at this brewery showed that during the preceding three months the greater majority of them had been ill, suffering in a similar manner to Dr. Cran's patients. This appeared to point conclusively to the beer from this particular brewery as the cause of the mischief; but further cases were heard of, and these were not traceable to the same brewery, although beer seemed to be the medium through which the illness had been caused in each instance, and in all subsequent inquiries every case investigated proved to be a beer drinker. The amount drank varied very much, viz., from a pint to sixteen pints per diem. The possible cause of the symptoms was considered, and lead poisoning appeared the most probable. An examination of several patients, however, proved the entire absence of the special symptoms of lead poisoning, such as the blue line on the gums, colic, etc. I was well acquainted with the fact that the higher alcohols, especially amyl alcohol, rapidly produce peripheral neuritis, even in small doses, and considering it possible that some degeneration of the yeast might have caused the production of this substance in the process of fermentation, I requested the analyst to examine the samples of beer for it, but at the same time I requested him to make a full investigation into the beer, as there was no doubt as to the fact that it was poisoning people to a most alarming extent. The analyst informing me that he could find nothing in the beer to account for the cases, arrangements were then made with Professor Delépine, on November 16th, for a complete examination of the beer, including physiological experiments should the preliminary examination prove the absence of mineral poisons. This preliminary examination was in progress

Traced to Beer.

Question of higher alcohols.

Mr. C. H. Tattersall.

22 Feb. 1901.

Traced to glucose contaminated by arsenical acid

when, on the 20th of November, we heard of the discovery by Dr. E. S. Reynolds of arsenic in beer, and this observation was at once confirmed. On the 21st, samples of everything used in each of the five breweries situated in Salford were obtained, and on the 22nd a complete set from one brewery was submitted to Professor Delépine, who discovered arsenic in one sample of glucose in large quantities the same evening. On the morning of the 23rd I visited the brewery concerned and obtained the address of the firm which supplied the contaminated glucose (Bostock and Co., Ltd.), and visited their office in Liverpool and their works at Garston, where I obtained a complete set of samples of the raw materials used in the process of manufacture, and the finished products ready for use. On the morning of the 24th arsenic in very large quantities was found in the sulphuric acid, and I visited Messrs. Nicholson and Son, Leeds, who were the acid manufacturers. Here I failed to get any information which could explain the reason for the epidemic commencing in June, but from the evidence afterwards given before the Manchester Coroner it appears that in March Messrs. Nicholson commenced to deliver to Messrs. Bostock a commoner sulphuric acid, which contained arsenic, in place of de-arseniated acid as delivered previously. I ascertained that Messrs. Nicholson manufactured their sulphuric acid entirely from pyrites, and that they used a process to de-arseniate a portion, the remainder being sent out crude. They had supplied Messrs. Bostock for a long period of years, and state that until March, 1900, they invariably sent de-arseniated acid; but at that time they changed their practice and sent the crude acid, which contained large quantities of arsenic. They stated that they had no knowledge of the purpose for which the acid was intended. There are some indications that Bostock's sugar was liable to contamination even before this date, for it is a fact, that there is a marked rise in the deaths from peripheral neuritis from the time that Bostock's sugars were more largely used in the local breweries, *i.e.*, from the latter part of 1896. At the same inquest it was shown that Messrs. Bostock employed a chemist at their works, and a consulting chemist, but neither of these gentlemen systematically examined the sulphuric acid delivered by Messrs. Nicholson. It has been impossible to obtain anything approaching accurate information in respect of the extent of the illness caused by arsenicated beer in Salford. For obvious reasons the public generally have been very reticent and expect their medical attendants to be the same. There can be no doubt, however, that a very great number (probably some thousands) have suffered to a greater or less extent in Salford."

Extent of Epidemic.

I may add here that almost all the cases that are returned to me in the list are cases among the poorer classes of the population, but that they are not alone the sufferers I know from my own personal knowledge. I know of instances where people in better positions in life have suffered exactly in the same way, although none have come officially to my notice. I have no reason to believe that the cases I know of are the only ones.

8. (*Sir Wm. Hart-Dyke.*) Do you mean as part of this especial outbreak, or previously?—As part of this especial outbreak. I am only indicating one of the reasons for thinking that we by no means know of all the cases. There were 996 cases reported from all sources. With regard to 366, I have no particulars as to their sex. Of the balance 281 were males, and 349 females. There can be no doubt that a very great number, probably some thousands, have suffered to a greater or less extent in Salford. I am basing that on the remarks I have just made, and on another statement which I now go on to give from the report.

"One medical practitioner informs me that in August and September he had a great number of cases of herpes zoster, and I know of several instances where persons who were in the habit of drinking some of the incriminated beers, in strict moderation, found in June, July, and August that the beer caused disturbance of the digestive functions, such as vomiting and diarrhœa, and they ceased to take them. So far as I have been able to ascertain there was a marked falling off in the amount of beer consumed in the district about the end of September, two months before the discovery of the poison, showing that many persons must have been affected in a similar ay. In one hundred and fifty cases the source of the beer was carefully traced, and it was found that in every instance where one brewery could be connected with the poisoning, that brewery was using Bostock's sugar."

Mr. C. H. Tattersall.

22 Feb. 1901.

In thirty-seven cases out of 150 it was impossible to connect them with any one brewery. The individuals drank beer in a promiscuous manner. But in the balance we were able to establish the fact that they obtained their beer regularly from one or at most two public houses, although they might have drunk other beer as well. Still, there was one regular supply, and these I have been able to allot to the various breweries concerned.

Fatality.

"The deaths resulting from the special amount of arsenic contained in Messrs. Bostock's brewing sugars from May to November can only be estimated by comparing the deaths registered from chronic alcoholism, peripheral neuritis, or alcoholic neuritis in the period from June, 1900, to January, 1901, with those from the same causes in previous years, and taking in addition the deaths registered as due to cirrhosis of the liver treated in the same way. Thus, from June 1st, 1900, to January 31st, 1901, there were registered from—

Peripheral Neuritis - - - -	47 deaths.
Alcoholic Neuritis - - - -	10 deaths.
Multiple Neuritis - - - - -	2 deaths.
Chronic Alcoholism - - - -	32 deaths.

or a total of 91 deaths in the eight months, as compared with seven, the average number for the same period in the preceding five years. This leaves a total of 84 deaths which may be considered to be due to the poisoning, in addition to those which were certified as cirrhosis of the liver. In the year 1900 there were 52 deaths registered as due to cirrhosis of the liver, as compared with 30, the average for the preceding five years, which leaves an additional 22 deaths in all probability due to the poisoning, especially considering that the post-mortem examination of the victims showed that even where large amounts of alcohol had not been taken the liver was greatly hypertrophied. There was one death registered from Addison's disease, and I have good reason to believe this was due to the arsenical poisoning. This makes a grand total of 107 deaths in Salford up to the end of January, 1901, probably due to arsenical poisoning from beer, and there can be no doubt that many of the persons still suffering from the effects of the poison will succumb in the near future.

The first chart* shows the number of deaths from peripheral neuritis in each half year from the beginning of 1890 to January, 1901. It will be at once noticed that there is a marked increase in 1897, and it is a somewhat remarkable coincidence that in 1896 Messrs. Bostock became a limited company, and pushed their business much more energetically in this district than formerly. The amount of their sugar used in the local breweries was greatly increased from October, 1896. So far as I have been able to ascertain (quite apart from the change in the sulphuric acid in March, 1900), they have always used an acid made from pyrites which was necessarily liable to contamination; and I feel convinced that there has for the past three years at least been some poisoning by arsenic in beer, although not to an extent to attract any attention. It appears possible that arsenic in association with alcohol is more dangerous than under other conditions, and it is certainly possible, to say the least, that a considerable proportion of the cases which have been looked upon as true 'alcoholic neutritis' have in reality been cases of very chronic arsenical poisoning."

I do not think I need go into the clinical symptoms, except just my own observations at the end.

Turning to page 22 of my report, I go on to say:

Clinical differences between earlier and later cases.

"There can be little doubt that the earliest cases did not present the symptoms of poisoning in the same marked degree as the later ones, being little, if any, different to the case of alcoholic peripheral neuritis which have been well known in this district for the past ten years. I examined a considerable number of cases before I saw one which presented all the symptoms which I have classified below, but at the end of November the running of eyes and nose, pigmentation of skin, keratosis, and paralysis were very general. I have tabulated below the results of replies received from medical practitioners respecting the symptoms of 296 cases. Those are necessarily incomplete and somewhat unsatisfactory, as in many instances no account of cases had been kept, but as regards their main features they are doubtless fairly correct."

From this it appears that nerve disturbances, sensory and motor, are the marked features of the cases; skin

* Appendix No. 1.

affections, running of the eyes and nose, and pigmentation are also well marked, but gastro-intestinal troubles are not well marked. I call attention to that, because it has been considered—at an rate, I have considered it—one of the prominent symptoms of arsenical poisoning. "In 630 instances I have obtained particulars as to sex, which shows that 281 males and 349 females were affected. The mortality figures show, however, that women are much more liable to succumb to the effects of the poison than men. Thus, out of 115 deaths 28 were males and 87 females. It is impossible to say whether this is due to the females taking more of the poison, or whether their powers of resistance are less. Probably it is a combination of the two reasons." I may say that it is commoner for women to obtain their beer from one source of supply than for men, and that may have something to do with the effects seen.

"With regard to age, it is found, as might be expected from the source of the poisoning, that the disease has limited itself to adults. Thus the youngest person attacked, out of 457 cases inquired into, was 19 years of age, and as shown in the accompanying table, the greatest number of cases were among persons from 40 to 50 years of age. It is impossible, with any advantage, to compare the number of persons attacked at the various age-periods with the number of persons living in the borough at those ages, as there can be no doubt that only a portion of the total number of cases has come to our knwledge. In 279 cases I have been able to ascertain the date of the commencement of the illness, as shown in the following table:—

June.	July.	August.	Sept.	October.	Nov.	Dec.
16	24	33	61	69	76	—

From this it will be seen that there was a steadily increasing amount of sickness up to the end of November. In two or three other cases the time of commencement was prior to June, one of these being stated to be four years; but there appears clear evidence that the present outbreak commenced in June and ceased at the end of November. This period corresponds almost exactly with the time during which the brewers were using sugars supplied by Bostocks, manufactured from Nicholsons' arsenious B.O.V. acid." "Nicholsons state the change took place in March, and Bostocks that it would be about a month before the sugar would get round to the brewer, and it would be two to three weeks more at least before it could reach the consumer. This brings it to the latter part of May before the affected beer came into circulation, and naturally the symptoms began to develop early in June. It is safe to say that, after the 30th November, none of the contaminated sugar was used by any brewer in Salford. It should be clearly stated that the most careful inquiry in Salford has failed to discover any case of this type of illness, the symptoms of which did not commence prior to the first of December last. For obvious reasons it is exceedingly difficult to obtain anything approaching accurate information as to the amount of beer consumed by any individual, and there is a strong tendency to minimise the quantity in most instances. The information in the following table which represents an analysis of 150 cases, has been carefully sifted, and made as accurate as possible."

Amount of Beer drunk as shown by Analysis of Particulars obtained respecting 150 cases.

Small amount, not exceeding one quart daily -	53
Medium amount, not exceeding half-a-gallon daily	44
Large drinkers, exceeding half-a-gallon daily -	53

From the table it is shown that 53 persons did not exceed one quart a day, 44 exceeded a quart, but did not exceed half a gallon daily, and 53 exceeded half a gallon daily, in one case going up to 16 pints regularly drunk.

"From this table it would appear that the disease has attacked all classes of drinkers equally, but it must not be forgotten that the small drinkers represent a large proportion of the whole population, whereas the heavy drinkers represent a very small minority. It, however, shows that in about one-third of the cases the sufferers were very moderate drinkers. Assuming that the beer contained on the average ¼ of a grain per gallon, which is, I think, a fair assumption, the amount of arsenic taken in a week by one of the class of small drinkers would be about half a grain, and considering that 1-20th of a grain of arsenic would be a dangerous quantity to take daily for an unlimited period, it is easy to understand that susceptible persons might be poisoned. The second class would take about 1 grain per week, and the third from 2 grains to 4 grains per week. On the 23rd of November, I communicated with the brewers who used contaminated sugar in Salford, and they immediately stopped its use; they sent out no beer which had been brewed with it, and on the 27th they communicated with their customers placing an embargo on all beers until they could be examined by their analysts. On the 29th I issued a circular to all beer retailers in the Borough, as follows:—

"'November 29th, 1900.

"'It has been ascertained that a great number of persons have of late suffered from poisoning by arsenic, through drinking contaminated beer.

"'I have now to inform you that the sale of any such contaminated beer is a serious offence, liable to severe punishment, and that the Food and Drugs Inspector will take samples for analysis without any further warning.'

"On December 3rd I commenced taking a large number of samples (under the Food and Drugs Act), all over the borough, with the result that out of 73 samples submitted to analysis the greatest amount of arsenic found in any one was 1-200th grain per gallon, and this beer had not been brewed from Bostock's sugar. Thus it appears safe to say that no beer was sold in Salford with a deleterious amount of arsenic after the 1st of December. Cases continue to occur, and deaths have continued up to the time of writing, and appear likely to continue for some time, but these were found after careful inquiry to be all due to the effects of poison taken before the 1st of December. It must not be forgotten that the effects of chronic arsenical poisoning do not necessarily pass off when the poison is discontinued, and that in a very large number of cases irreparable damage had been done to the tissues and organs, and disease set up which is still running its course to terminate in the death of the patient or his more or less permanent disablement. So far as I have been able to ascertain, over 12,000 barrels of beer (representing 432,000 gallons) were destroyed in Salford."

I come then to the sections of the report which deal with matters with which the Commission are probably better acquainted than myself. It was obviously necessary for me to make inquiries into a number of things, and to obtain samples and submit them to analysis, and in this report a short account has been given of what has been done in that way, and a short statement made, with a summary of information that has been given to me by brewers, maltsters, and others, respecting which I cannot speak with any special knowledge. It is purely information that I have obtained on this occasion.

9. *(Chairman.)* I think this information would be very valuable to the Commission taken under the conditions that you describe?—Very good, my lord. "A short indication of the processes adopted in brewing beer will assist in understanding the way in which the arsenic found its way into beer, and so caused the epidemic of poisoning. Brewing is essentially the producing of an alcoholic beverage by subjecting solutions of grape sugars"—I use that term in its colloquial, not its strictly chemical, sense—"to the action of yeast, and flavoured with hops. The form of grape sugar used most largely is malted barley; that is, barley which has been allowed to germinate, the starch of the barley grain being converted naturally into grape sugar. A large quantity of beer is brewed from malt and hops alone, but generally some other form of sugar is used in addition to the malt, or rather, in substitution for a portion of the malt which would otherwise be required. In some instances, raw starchy substances are added to the malt in such quantities that the diastatic ferments in the malt are able to convert them into sugar; in other cases, and more commonly, a manufactured sugar is introduced. This is either 'glucose,' a substance which is prepared from starches such as maize flour, sago, tapioca, etc., by the action of sulphuric acid; or 'inverted sugar,' which is prepared by treating cane sugars with sulphuric acid. There are many trade names for substances used, but they all fall under one or other of these headings. I

Mr. C. H. Tattersall. 22 Feb. 1901

Action of M.O.H., and local authority.

Destruction of beer by brewers.

Mr. C. H. Tattersall.
22 Feb. 1901.

am informed that, to make 400 parts of beer the brewer takes 100 parts of solid material (75 per cent. at least of malt and from 6 to 25 per cent. of substitutes) and adds 500 parts of water. This is mixed in the mash tun, and the resulting wort or mixture is boiled together with the sugar and hops in a copper vessel; the boiling fluid is then filtered through the exhausted hops and cooled, yeast is added, and fermentation takes place. The yeast is afterwards removed, and the beer run off into barrels. Various other substances are used in the brewery, in addition to glucose, malt, hops, and grain. In summer, it is said to be desirable to add some substance to prevent the beer turning sour, and various forms of preservatives are used, which appear to be largely sulphites. 'Priming' is added to the barrels of the cheaper beers by some brewers; this is usually a limited quantity of inverted sugar. Then 'finings' are added to the barrel by the beer retailer. The only specimen of 'finings' I obtained was isinglass. Thus two substances, malt and sugar (glucose or inverted sugar), are used in considerable quantity, and a number of others, yeast, hops, preservative, priming, and finings in small quantities. I believe hop substitutes are also occasionally used, but I do not find any in the five breweries examined. Consequently the two substances which above all others should be kept pure are malt and sugar, since small amounts of impurity in the others would not affect the beer to any material extent.

Arsenic in Nicholson's acid,

The analysis of the sulphuric acid obtained from Messrs. Bostock's works showed that apart from the precipitate it contained at least 1·45 per cent. of white arsenic."

10. (*Chairman.*) Apart from the precipitate, what happened?—The sample of acid we obtained, on standing, deposited a considerable precipitate.

11. Without any treatment?—The acid, without any treatment.

12. It showed a precipitate?—It did, and that precipitate is very largely, if not almost entirely, arsenious acid; but Professor Delépine will deal with this question, from the scientific point of view. The fluid, apart from the precipitate, contained this very large proportion of arsenious acid, 1·45 per cent.

13. (*Professor Thorpe.*) Is it not a fact that the precipitate might largely consist of sulphate of lead?—It did not. That was what we thought it was when we filtered off the precipitate and examined the sulphuric acid in the first instance. We did not think we were taking the arsenic out to any extent, and thought it was probably sulphate of lead, but further examination has shown that it is not sulphate of lead, but practically almost pure arsenious acid—white arsenic.

14. (*Chairman.*) We shall hear from Professor Delépine perhaps, but did the precipitate contain nearly pure arsenious acid? Perhaps it contained more arsenic than that which was left in the solution?—That is the reason why I give the analysis here of Dr. Campbell Brown, of Liverpool, and Mr. T. A. Reid, of Liverpool, as given in their evidence before the coroners. They found that the total percentage of arsenic in the sulphuric acid was at least 2 per cent., rising in one sample to 2·6 per cent.

15. Per cent. by weight?—Yes, per cent. by weight. I go on to say in my report: "This would more than account for the largest amount found in Messrs. Bostock's glucose, namely, ·095 per cent., and this again would account for at least 2 grains per gallon in the beer. As a matter of fact, 1·5 grains per gallon is the highest amount found in the beer." I might refer here to the table of analysis. (*See Appendix No.* 12.) Table 3 has been worked out to show the amount in grains per gallon approximately of what arsenic is in these samples of beer. All those marked with a star were beers brewed more or less from Bostock's sugar, and it will be seen that the amounts vary very much, from 1-30th to 1½ grains per gallon.

and in Bostock glucose,

16. (*Professor Thorpe.*) Are these Professor Delépine's observations?—They are.

17. This is marked as "private." Does that mean a private brewery?—Yes.

18. Was it not for sale?—Private is meant to indicate there that it was not a sample I took officially, but a sample that reached us in another way.

19. Was it beer for sale?—It was beer for sale, only it did not come from Salford, but from another district. That is really the explanation. These are Professor Delépine's tables (*see Appendix No.* 12.), and he will explain the source of the sample when he is before you. "The cause of so much variation in the amount of arsenic appearing in the beer is—first that there can be no doubt the acid itself varies greatly from this point of view. Then the amount of arsenic removed from the glucose by the charcoal filters will vary very much; and again, the amount of glucose used by different brewers is a very variable quantity. Some brewers mixed the Bostock with other sugars, and so again reduced the amount in the beer. In beers not brewed with Bostock sugar the highest amount has been 1-28th grain per gallon, and this was brewed in a brewery where Bostock sugar had previously been used. I should not be prepared to say that it is quite safe to drink beer which contains 1-100th grain or more of arsenic per gallon. A full medicinal dose of arsenic is 1-12th grain, and that is rarely given even under the constant supervision of medical men. The more usual medicinal dose would be from 1-20th to 1-50th grain of arsenic." I may say that I myself have seen symptoms of arsenical poisoning, vomiting, and diarrhœa resulting from an odd dose of 1-50th of a grain.

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Variations in quantity of arsenic in the implicated beers.

20. (*Chairman.*) From one single dose?—From one single dose. That was in a patient who was very peculiarly susceptible to arsenic, and it was tried for a number of years several times over, always with the same result. I state this simply to indicate that to some individuals an extremely small amount of arsenic is a dangerous thing.

Individual susceptibility to arsenic.

"As the beer brewed from Bostock sugar contained on the average 1-32nd of a grain of arsenic per pint, it is at once seen that the phenomena of poisoning are accounted for, and from the fact that the amount may have been 3-16ths grain per pint it can be understood that, as appears to have frequently happened, an odd pint of the contaminated beer has been sufficient to produce very unpleasant symptoms in individuals. Instances where this occurred have been authentically described to me. Glucose is prepared from various starches by the action of sulphuric acid and heat. Maize, sago, tapioca, wheat, and rice flour are all used for this purpose. The flour is thoroughly mixed with water, and sulphuric acid added to the extent of about 6 per cent. The mixture is boiled for about two hours and then run off. Whiting is added to the liquid, and this neutralises any acid not used up in the process of converting the starch into grape sugar. The mixture is then pressed through canvas bags which remove all suspended matter, and is filtered through animal charcoal, in some cases several times. The clear liquid is treated with sulphurous acid, for the purpose of bleaching it, and is placed in pans and concentrated to a point at which when cooled it will become a solid substance. Inverted sugar is prepared in a manner exactly similar to glucose, except that cane sugar is used instead of starch, and the sulphuric acid is added in smaller quantity, 2 to 4 per cent., instead of 6 per cent. as in the glucose. It is also not heated to so high a temperature, inversion being carried on at 160deg. Fahrenheit. In each instance the resulting product is a perfectly harmless and satisfactory form of grape sugar, provided that pure materials are originally used, and it is found in practice that the filtering processes take out undesirable substances. Thus traces of arsenic are taken out in the charcoal filters. An examination of the charcoal used by Messrs. Bostock showed that the charcoal from the used filters (it should be used once only and then reburnt) contained large quantities of arsenic, whereas the reburnt charcoal from the same filters contained smaller quantities of that substance. Glucose is used for a number of purposes, namely:—malt substitute in brewing, in the preparation of leather, by jam makers (especially makers of whole fruit jams, which fetch the highest prices), in confectionery, and in the preparation of the clear breakfast syrups, which in many cases are almost entirely glucose. The samples which I have seen of glucose used in the three latter processes were much clearer than for the two first, being an almost transparent colourless fluid. It is thus evident that arsenic present in the sulphuric acid used would contaminate the resulting sugars, and it is the practice for glucose manufacturers to use either sulphuric acid guaranteed free from arsenic, or acid manufactured from native Sicilian sulphur only. It would appear desirable that in the future the only sulphuric acid used in the preparation of food stuffs should be that manufactured from native Sicilian sulphur, as it is obvious that a mistake in the labelling or delivery of a carboy from a works manufacturing pyrites acid might have very serious results, and accidents of this kind can be best guarded against by prohibiting the use of any pyrites acid for such purposes. The manufacture of sulphuric

Manufacture of glucose.

Arsenic in charcoal filters.

Acid from Sicilian brimstone should be used for food purposes.

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acid is a much better known process than that of glucose and invert sugar, and there is no need for me to refer to it further than to point out the difference in the source of the sulphur which is used. The purest acid is made from native Sicilian brimstone. This alone should be used whenever the ultimate destination of the manufactured product is human consumption, and as sulphuric acid is used in the preparation of many articles, or in cleansing vessels, etc., it should be widely made known that native Sicilian brimstone acid should be required in all such cases. So-called brimstone acid is also prepared from recovered sulphur from alkali works and from spent oxide from gas works. It is most largely prepared from pyrites. One witness at the coroner's inquiry into this matter stated that 98 per cent. of all sulphuric acid made was produced from this source."

21. Is that called brimstone acid?—It was said so at the inquest. It was said that de-arsenicated sulphuric acid is sold on the market as brimstone acid. That was the evidence of one witness I think

22. (*Professor Thorpe.*) Were you present at the inquest, and did you hear that statement?—I was, and did.

23. Was the statement made that it was brimstone acid or merely stone acid?—Stone acid was stated to be the common term used, stone acid being, according to the evidence of the witness, equivalent to brimstone acid—a shortened form of brimstone acid.

24. Was the fact elicited in the course of the coroner's inquiry that the workpeople are in the habit of calling pyrites stone?—No, that was not.

25. (*Sir William Hart-Dyke.*) You mean that the witness wished it to be inferred that "stone" was really an abbreviation for "brimstone"?—That was so.

26. (*Chairman.*) There might have been an ambiguity. Some witnesses might have imagined the common use of the word "stone" was in respect of pyrites acid?—It might have been, only it was not mentioned at the inquest that it was. It seems a probable thing. Then I go on in the report:—

"With regard to arsenic the first quality (*i.e.* Sicilian brimstone acid) is practically pure. The second should not be contaminated, but is not so safe as the first. The third, unless treated specially to remove arsenic, always contains that substance, and in any case the acid from pyrites should not be used in the preparation of any articles for food, as even if de-arseniated acid be used, a mistake at the acid works might have the most serious consequences. The amount of arsenic in the samples of sulphuric acid from Messrs. Bostock's works and supplied by Messrs. Nicholson varied from 1·4 to 2·6 per cent. by weight of arsenious acid. As Messrs. Nicholson were delivering to Bostock's seven to ten tons of this acid weekly for a period of eight months, from four to six tons of white arsenic were used in the preparation of this glucose and invert sugar during that period, and it is not surprising that the effects have been so disastrous. A further result of this investigation has been the discovery that arsenic is in small quantity frequently present in beer apart from the use of contaminated sugar. The amount is very variable, ranging from five parts in 10,000,000 to the slightest traces. The possibility that occasionally the amount may greatly exceed the largest quantity found in the course of the inquiries cannot be ignored, and it was obviously important to discover the source of the contamination. In malt variable quantities of arsenic were found, and it was also observed that the quantity varied in different samples from the same malting. The large quantity of malt used in brewing makes any impurity a very serious matter, and inquiries were made to discover the source of the contamination. I visited several malt kilns and various samples were submitted to analysis, and it was proved that practically all the arsenic was introduced in the process of kilning and the amount varied with the fuel used. Thus in malt dried with gas coke fires arsenic was found in considerable quantity, reaching 1-80th grain per pound, which might produce as much as 1-32nd grain of arsenic per gallon of beer when used in brewing." That is, provided all the arsenic got through into the beer, which is an impossibility in actual practice, because the arsenic contained in the original ingredients does not all get through into the beer. Some is taken up by the yeast, some is deposited on the copper and the vessel and some is probably thrown down in the course of the precipitation of the albumoses in the cooling of the wort in brewing.

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"In those dried with washed smelting coke the quantity was less, and in those dried with anthracite coal the quantity was least. Some malts were found practically free, and these it was discovered had gone through another process after kilning, viz., brushing and polishing, which appeared to remove the impurities from the surface of the malted grain, where it is deposited from the furnaces in process of kilning. It is interesting to note that the samples most free from arsenic were dried on kilns constructed on the double floor principle. Some roasted malts were also found quite pure, and these had been roasted in drums after being dried in the usual kilns, the polishing in the heated drums apparently removing any arsenic. From these results it would appear that it is very desirable that anthracite coal alone should be used for kilning malt, and that the malt should invariably be brushed and polished before grinding for the mash-tub. It would also appear that if malt could be dried in drums without any contact with the fumes from the fuel without losing its flavour, it would be the most satisfactory method. Six samples of barley were examined, and three proved to contain traces of arsenic. It was ascertained on further inquiry that two of these had been kiln dried, so that only four samples of pure barley were analysed, and one contained a slight trace of arsenic. There is not the slightest danger of beer being contaminated from the barley itself, as in the process of malting and brewing the slight trace present in the grain would be so diluted as to become unrecognisable if even it was not lost in the process. Twenty samples of hops have been examined, and although small quantities of arsenic have been found in many of the samples, the quantity, taking into consideration the amount of hops used in brewing, could not possibly cause any injury through the beer. Arsenic when present is probably due to the same cause as in malt, that is, the use of impure fuel in kilning, or the use of impure sulphur on the fires. It is difficult to conceive that contamination could be conveyed to beer through the medium of yeast. The yeast appears to have some power of taking up arsenic, but its influence would probably have the direction of diminishing the amount in the beer and not increasing it."

derived from the fuel on the kiln.

Arsenic in yeast.

27. Might not yeast that had been used from a previous browing carry with it the arsenic?—That opens a question that is being investigated at the present moment by Professor Delépine. Although it appeared in the first instance that the addition of a quantity of yeast which increases largely in the process of brewing—the quantity added to the wort grows to a very great extent in the process of brewing—at the end of the time the whole of that yeast is found to contain arsenic if arsenious yeast be used; but still I believe Professor Delépine has found that strongly contaminated arsenious yeast will give a little arsenic to beer which otherwise would be pure. That is the outcome of experiments which he is at present completing.

28. (*Professor Thorpe.*) Do you know in what form the arsenic is in the yeast?—I do not. I go on to say:

"The analysis of certain samples given in Professor Delépine's report shows that the possibility of contamination with arsenic from these substances cannot be disregarded, and they should be carefully watched. The use of preservatives opens up the further question of the possibility of the use of substances which might be dangerous in other ways, but it must not be forgotten that they are only used in very small quantities. My conclusions are: (1) It may be considered proved by the clinical symptoms, the presence of arsenic in the urine of patients, and in the body of patients who died, that the cause of this outbreak of epidemic disease was poisoning by arsenic."

Dr. Dixon Mann and Dr. Stevenson found it in the body. We report here an analysis by Professor Delépine of a sample of urine containing a large quantity of arsenic:

"(2) That the arsenic was due to the drinking of beer in the preparation of which sugar from Messrs. Bostock and Co. was used, and that this sugar was prepared from exceedingly contaminated sulphuric acid supplied by Messrs. Nicholson, of Leeds. It may be stated clearly that if beer had been brewed from malt and hops alone no serious damage from poisoning with arsenic could have occurred, although malt more or less impure might have been used by the brewer; and in the light of the results of this investigation it may be considered equally certain that there is no reason why beer brewed from malt and hops should under any circumstances contain more than $\frac{1}{200}$ grain per gallon, as the use of anthracite

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fuel in the preparation of malt and subsequent brushing and polishing give a practically pure article. Again, it is quite clear that glucose and invert sugar as usually prepared are absolutely innocuous substances, and considering the fact that chemical science is progressing so rapidly in the direction of replacing natural products with manufactured articles, it would appear unreasonable to forbid the use of these substances, provided that some means may be devised by which carelessness of one or more individuals can be prevented from endangering the lives and health of the public. At the same time it should be recognised that any person replacing a natural substance by a manufactured article in the preparation of any food stuffs, takes upon himself the responsibility of seeing that no injury shall ever result from such substitution. This naturally applies to many things in addition to beer. The only method of prevention is to go to the fountain head and deal with the chemical manufacturer, as many articles are prepared for food by small and ignorant tradespeople who might use dangerous substances without any knowledge of the danger. I would suggest that chemical manufacturers be compelled by law to label every article whether apparently meant for use in the preparation of food stuffs or not, which contains any known poison, with a statement that such poison (naming it) is present. This could only be properly carried out under the supervision of inspectors under the Central Government. The Foods and Drugs Act should also be amended so as to make the contamination of food stuffs with poisonous matter in appreciable quantity, whether to a dangerous extent or not, and whether to the knowledge of the seller or not, an offence within the meaning of the Act, as it is obvious that the presence of a poison in a small quantity is often an indication that there is distinct danger of a dangerous quantity being introduced at any time."

Recommendations.

All poisonous chemical substances should be labelled.

Food and Drugs Act should apply to poisons in food, whether to knowledge of seller or not

I pause there to add that the seller can always and ought always to protect himself by obtaining a warranty from the person from whom he obtains the substance he sells.

"Sulphuric acid made from native Sicilian sulphur should alone be used in any process which might affect food. This investigation has shown the great importance of some improvement being made in the arrangements for the notification to the health authorities of outbreaks of disease. Certain specified infectious diseases are notified under the Infectious Diseases Notification Act, but it should be recognised by the medical profession that the public have provided an organisation for the express purpose of dealing with outbreaks of disease, and notification of any disease of an unusual character should take place, as a matter of course. In this instance a large number of people were killed and a vast number were more or less seriously affected from the beginning of June, the number increasing steadily up to the end of November in Manchester, Liverpool, Salford, and many other towns, but it never seems to have occurred to anyone that it was worth while to put the machinery of an official inquiry into the cause of all this unusual sickness into motion, until Dr. Cran, of Regent Road, Salford, called upon me on the 9th of November; and I very much doubt if the other medical officers of health received any intimation until the press published Dr. Reynold's discovery. I find that there is an order of the Local Government Board issued in 1879 requiring lists of cases of new sickness treated by the Poor Law Medical Officers, to be sent regularly to the Medical Officer of Health. I do not know whether this order has ever been recalled but it has certainly fallen in desuetude. If still in force it should certainly be carried out, and it would be advantageous if the Local Government Board would regulate the fees to the Clerk to the Union which can be paid under it. This inquiry has shown that there is urgent need for some provision whereby regular scientific investigation—chemical and physiological—into the constitution of food stuffs and their adulterants, can be carried on continuously. This would tend to prevent similar calamities to the one from which we have suffered, and at the same time provide a readily accessible staff of trained observers to deal with such emergencies should they arise. In the present instance but for the exceptional kindness of Professor Delépine it would have been impossible to have traced and checked with reasonable promptitude this extensive poisoning in Salford."

Public Health Authorities, through M.O.H., ought to be informed of outbreaks of non-notifiable illness.

Provision needed for continuous scientific investigation of food-stuffs.

29. (*Chairman.*) Can you tell the Commission the population of Salford?—223,418.

30. Referring to a statement on page 26, you say: "It should be clearly stated that the most careful inquiry in Salford has failed to discover any case of this type of illness, the symptoms of which did not commence prior to the 1st December last." What steps have been taken to inquire into cases of illness after December 1st? I put this question in order that the Commission may be satisfied that the epidemic then came completely to an end in Salford?—Immediately after the beginning of December I sent out forms to every medical practitioner in Salford asking for particlars of any cases that he could give to me. I received lists from a large number, and subsequently, early in January, I sent again and inquired from these gentlemen as to any further cases that had come to their knowledge. I received them also from the Poor Law authorities and from the hospitals. The result was that in January I heard of 39 cases that had arisen and were not included in the original list. These 39 cases were inquired into, and in every instance the illness was found to have commenced before the 1st December, the illness in some cases going back to the middle of the summer.

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Termination of epidemic in Salford.

31. Then there was a statement on page 32 of your report, where you say: "Glucose is used for a number of purposes, namely, malt substitute in brewing, in the preparation of leather, by jam makers (especially makers of whole fruit jams, which fetch the highest prices), in confectionery, and in the preparation of the clear breakfast syrups, which in many cases are almost entirely glucose." As medical officer of health, have you any knowledge of any cases of illness resulting from any of these substances, confectioneries, jams, or syrups?—I have not. Samples of these substances have been analysed, but with entirely negative results.

No arsenic found in other foods made with glucose.

32. (*Professor Thorpe.*) Were those samples of English manufacture or of foreign manufacture?—I cannot say. They were samples bought in the ordinary way in the shops.

33. (*Chairman.*) How many samples of such jams or syrups have been investigated?—The number is not large. I could not say exactly; I should think not more than ten samples in all.

34. There is a question which perhaps I should not put to you, but if you can answer it, well and good, but if not, never mind. Have you any means of knowing whether Bostock's sugar was used for any other of these food stuffs, or was it solely sent out to brewers?—It was stated in evidence more than once in the Coroner's inquiries that Bostock's invert sugar and glucose were supplied to no one but brewers. I obtained that information in the first instance on my first visit to Bostock's works.

35. Also I wish to ask a question in respect of Nicholson's. The information you have had from Nicholson you refer to on page 7, where you say you had failed to get any information which could explain the reason for the epidemic commencing in June. Was there any reticence on the part of Nicholsons in answering questions?—I explained the position to Messrs. Nicholson, that an epidemic of arsenical poisoning had broken out, which commenced in June, and that it had been traced to Bostock's sugar, and through Bostock's sugar to their acid, and I asked them if, since the beginning of January, they had made any change, or what changes they had made in the sources of their pyrites.

Explanation of Messrs. Nicholson.

36. Since the beginning of January last year?—Yes, 1900. I asked if they had made any change in the source of their pyrites used in the manufacture of the sulphuric acid, of if they had made any change in the sulphuric acid. They told me there had been no change.

37. It was only from the evidence given before the Manchester Coroner that you are able to make the statement which appears regarding the change in the acid?—That is so. Up to that time it was a very difficult and unexplainable problem as to why the epidemic should have begun in June, but the coroner's inquiry cleared it up. I should explain that I think it is due to Messrs. Nicholson to say that when I saw them it was on a Saturday afternoon, and their works were closed. I saw the partners, and they said so far as they could remember—that was the way they put it—there had been no change made either in the sources of their sulphuric acid or in the deliveries to Messrs. Bostock. That is what they told me at that time.

38. It would not, therefore, be fair to consider that there was any wilful reticence?—I do not think it would be fair to think so.

39. The evidence that they gave before the Coroner then contains the information on which this is founded?—It does.

40. I just wished to know that, and to have our minds disabused of the idea that there was any wilful reticence on their part?—I should not like to say there was.

41. Referring to page 31, and the table, I see that you refer to the beer brewed from Bostock's sugar containing on the average 1-32nd of a grain of arsenic per pint. Casting one's eye over the numbers in the table giving the quantities per gallon, there being 8 pints in a gallon, one-eighth part of the numbers in Table I. would show the numbers on which the average 1-32nd is founded?—Not quite, because, for instance, some of the more contaminated beers are beers that are sold most largely in the borough, and that statement of 1-32nd cannot be said to be a scientific average at all. It is simply a rough average from a general consideration of all the conditions.

42. And to form a correct average, of course, one would need to weigh the figures given in Table 1 with factors depending on the quantities of the particular samples that were produced and consumed?—Yes.

43. A factor for the quantity would need to be multiplied into the numbers here before taking an average?—It would.

44. I wish to be clear on that point. We may think of 1-32nd of a grain of arsenic per pint as being an approximate average?—Yes, that is so; it does not profess to be anything more than approximate. I am personally of opinion that it is putting it at a minimum. Some of the beers have certainly been much more contaminated than others. The beers from the same brewery vary at different times, and I believe that if we had had more beer to go on, we could have done better. The difficulty is that all the beer has gone as far as we are concerned. We have not been able to obtain any of the beer since the beginning of December, and our inquiry into it has been limited somewhat in that way. But I believe more would have been found if we could have had more beer to work on. That is simply an opinion—it is not worth much.

45. It is certain that in many cases the quantity was more than 1-32nd of a grain per pint?—It is.

46. (*Sir William Hart-Dyke.*) You, of course, wish the Commission to understand, so far as this large and sudden mortality was concerned, that the cause was clearly defined by the limit which you give of December 1st?—I do.

47. And after the various investigations into the subject, and the alarm that was caused, and the large district which was supplied with this drinking material, you can point to December 1st as a date which indicates clearly no doubt as to what the special mortality came from at that period?—That is so.

48. You point rather, do you not, on page 12 of your report, to the possibility that for many years past, or for a considerable period, the type of disease which has been called alcoholic neuritis may have been miscalculated by medical men, and it may be possibly that it proceeded from other causes, that is to say, from the presence of arsenic in the beer?—I think that for this reason: that when this particular attack, which I think is clearly traceable to one particular lot of arsenic contained in one particular substance—which is arsenic *per se*—when this occurred, the medical practitioners did not recognise it, and they did not recognise it for the simple reason that it was practically the same thing they had been treating before which had gone by another name.

49. (*Chairman.*) What called their attention to it was the great increase in such illnesses?—Quite so.

50. There was an abnormal increase?—Yes. It ran for five months before anyone thought of investigating it.

51. (*Sir William Hart-Dyke.*) You said further on in the report that there could be no doubt that only a portion of the total number of cases came to your knowledge or to the knowledge of medical men?—I mean that to my knowledge.

52. I suppose you have been medical officer for some years?—For three years.

53. And you have an intimate knowledge of the district?—Yes.

54. And you know a great deal also of the habits of the people?—Yes.

55. Have you any notion as to what proportion of cases have probably escaped altogether?—I have not. It is a problem on which I have thought a great deal, but I can see no way of getting at any information that would be valuable. The strongest indication that there has been a great amount of illness beyond what we know of is in the great dropping off in the amount of beer drinking. It became a joke in the workshops in the borough when men fell ill that they had been drinking beer.

Beer drinking diminishing before cause of outbreak discovered.

56. (*Chairman.*) There was evidence of that before November or December?—This was two months at least before I had any knowledge that there was any special illness.

57. The workmen themselves had found there was something wrong with the beer?—Yes.

58. Did they drink other beer, or give up drinking beer?—They drank whisky, I think.

59. (*Sir William Hart-Dyke.*) But previously to that is it not possible that in very many cases, where a person may have felt he had drank more than he ought to have drank, he may have attributed any illness he suffered from to excess, and therefore have been rather averse to approaching a medical man?—As I say, I heard of no cases except amongst the poorer classes of the population. I do know that members of other classes have suffered, and I am quite confident that the few cases I know of are by no means isolated ones. But at the same time people in that position in life would not themselves give any information, and would be strongly averse to their medical men giving any information with respect to their illnesses.

Former knowledge of liability of glucose to be arsenical.

60. You refer a little later to the question of brewing from malt only, and you very rightly say that the large quantity used makes any impurity in it a very serious matter. I suppose you have never had the least suspicion of the possibility of malt containing arsenic?—I have not. When this inquiry began, I may say that the possibility of the presence of arsenic in beer never occurred to my mind in the first instance, although it is referred to in Dr. Wynter Blyth's book, and there are researches by Clouet and others. Still it was not a recognised thing.

61. (*Professor Thorpe.*) Dr. Wynter Blyth's book makes no reference to beer, does it?—No. It makes reference to glucose, and of course knowing that glucose was used in beer; it is not in the article on beer in Dr. Wynter Blyth's book, to which I referred, but in the article on glucose; had I seen that reference I should have probably suspected arsenic earlier. As I did not, and I had never heard of arsenic being in beer, I did not think of it.

Risk from arsenic much less in all-malt beer than in beer brewed from glucose.

62. (*Sir William Hart-Dyke.*) You state clearly in your report that if beer had been brewed from malt and hops alone, no serious damage from poisoning with arsenic could have occurred?—That is my distinct opinion.

63. And you also say that under no circumstances could beer brewed from malt and hops alone contain more than $\frac{1}{250}$ grain per gallon?—That is provided certain things are done.

64. One being the use of anthracite fuel in the preparation of malt and subsequent brushing and polishing?—If proper means are taken to make the malt free from arsenic, there is no reason why any beer should contain more. We did not find in any beer brewed from malt of that description more than $\frac{1}{250}$ grain per gallon.

65. And you think that complete security can be obtained by a very simple process?—I do.

66. You think in fact that with the commonest care on the part of the brewers the consumer would have complete security?—I do.

Alcoholic and peripheral neuritis.

67. (*Sir William Church.*) When did you first use in the Register of Deaths alcoholic neuritis and peripheral neuritis?—I should not expect to find deaths attributed to it earlier than 1886, but from 1886 onwards it became generally known to the medical practitioner that peripheral neuritis was often alcoholic.

68. It would be 1885 or 1885—I would not be certain of the year—that it first appeared in the nomenclature of disease?—That is so.

69. Then for a considerable number of years few deaths would have been probably registered under that term?—That is so.

70. So that it is quite possible there might have been more deaths in 1890 and 1891 from that cause than appears in this table?—I am inclined, as far as an opinion is worth anything, to think that that small rise shown in 1893 may be considered to correspond with

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the rise in final knowledge on the part of the profession in the use of that term.

71. And you think that by 1897 that form of disease, leading on to death, was fairly generally recognised by the profession in Salford?—Certainly, in our neighbourhood.

(*Chairman.*) Alcoholic neuritis is what you speak of?

(*Sir William Church*). Yes.

long been associated with beer and not spirits.

72. (*Chairman.*) Has that been connected with the use of spirits, whisky, or gin, or brandy, or only with the use of beer?—It has been considered generally that alcoholic neuritis was more likely to be produced by spirits than by beer; but our local experience in Manchester all through—and I may say that this subject was worked out in Manchester by the late Dr. Ross and Dr. Dreschfield—led me to believe that beer drinkers have been the predominant factor in the returns of alcoholic neuritis. But it is produced by spirits, and believed to be more produced by spirits than by beer.

73. (*Sir William Church.*) Has it not been found, since the form of disease has been recognised, that it is generally more fatal in women than in men?—That is the case, I believe.

Incidence on sex.

74. And men drink more beer, do they not, than women?—They do. They drink more spirits also. I say they do, but I mean they are believed to do so. My own impression, from the habits of the population that I have studied locally, and it is an impression which it is impossible to adduce positive facts to prove, is that the heavy drinker, the drunkard, certainly, takes a larger quantity of alcohol than women drinkers; but the average moderate-drinking man does not take as much as the average woman drinker, who sits at home and sends round the corner for a jug of beer twice or three times in the course of the day. She certainly takes more than is generally believed. That is my opinion.

75. But you have no reason for thinking that women are more apt to suffer from ordinary arsenical poisoning than men?—I have no reason to think so. These figures would seem to show that men suffered nearly as often as women, only they did not die. The mortality was much more severe among the women. I refer to the figures at page 24.

PARTICULARS as to Age and Sex obtained respecting 457 Cases.

	Females.	Males.
0—20	5	—
20—25	4	2
25—30	32	6
30—35	23	21
35—40	39	37
40—45	34	67
45—50	41	45
50—55	20	21
55—60	11	21
Over 60	15	13
	224	233

76. The numbers affected are much the same, 224 and 233?—Yes.

77. But you will see among the deaths in the paragraph above that out of 115 deaths 28 were males and 87 females?—Yes.

78. (*Dr. Whitelegge.*) The cases on page 24 are selected, are they not, because they do not mount up to the total of 996?—That is so. They are cases taken at haphazard.

79. Page 8, where you give the analysis, shows a very heavy incidence upon females?*—Yes, but there again you see a large portion of the total of the 996 have no particulars against them. In 366 cases no particulars are stated.

Explanations of Messrs. Nicholsons.

80. (*Sir William Church.*) Messrs. Nicholson, in fact, said that they did not change in any way the source of their pyrites?—That is what they told me. They told me that their office was closed, and they could not get at their books, and they could give me no definite information. But that was their impression at that time. What their exact information is now I cannot say. They stated they were Spanish pyrites that they used, but they did not give me the name of the mine.

* Cf. Q. 8, p. 3.

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81. On page 29 you say that various other substances are used in a brewery. I suppose you mean rather in brewing than in the brewery?—Yes, in brewing.

82. In addition to glucose you mention malt, hops, and grain. At the foot of that you refer to the antiseptic used in the finings of the beer?—I am referring really to what follows in the other paragraphs, the antiseptics, the finings, and the hop substitutes.

Arsenic in all-malt beer.

83. (*Mr. Cosmo Bonsor.*) Just on that question of brewing I wish to ask a question. You gave Sir William Hart-Dyke just now the impression that if beer was brewed entirely from malt and hops it would not contain more than a certain amount of arsenic, and you mentioned that you had analysed a certain number of samples. I presume you have the declaration that it was brewed from malt and hops only from the brewer?—Only from the brewer.

84. There is no means of analysis?—No.

85. There is no means by which you can tell whether the finished beer is brewed from malt alone, or from malt mixed with glucose?—No. There was a prosecution in Nottingham where the analyst stated that some glucose had been used in the beer, but I do not know the process by which he would tell that glucose was present in the beer.

86. Not after fermentation?—I do not know.

87. Not if it was brewed, certainly not. It might be if it had not been fermented, but I do not think there is any process?—I do not know of one.

No lead in beer.

88. I think the disease is very much of the same character as comes from lead poisoning?—All the metallic poisonings have similar characteristics.

89. So far as you know, there was no trace of lead poisoning in any of these beers?—They were all examined for it.

90. And you satisfied yourself practically that it was arsenic?—Decidedly; I satisfied myself it was not lead in the first instance, because lead was the first thing I thought of as soon as I heard of the cases.

91. (*Sir William Church.*) Lead poisoning is easily recognised?—Yes, it has certain characteristics.

92. It is very easily recognised by a medical man by certain definite signs?—Yes.

Questions of higher alcohols.

93. (*Professor Thorpe.*) Would you kindly tell the Commission why you know that the higher alcohols, especially amyl alcohol, produce peripheral neuritis?—I know of it because of a series of experiments carried on in the Owens College laboratories some years ago, under Professor Delépine's supervision. He experimented for a considerable period of time on the feeding of animals with various forms of alcohol, and one of his results was that amyl alcohol in comparatively small doses rapidly produced peripheral neuritis. Dr. Kerr is the gentleman's name.

94. The practical significance of that observation would be, therefore, a *primâ facie* case against beer producing peripheral neuritis?—Not necessarily, because ethylic alcohol he found did produce, only to a smaller degree, and in much slower time, similar results.

95. But beer does not contain any sensible quantity of amyl alcohol?—I was referring to ethylic alcohol.

96. I was asking with respect to amyl alcohol?—Beer in the ordinary way does not contain any perceptible quantity of amyl alcohol.

97. Ethylic alcohol would not be considered one of the higher alcohols?—No.

98. Therefore there is a *primâ facie* case against beer producing peripheral neuritis?—No, because ethylic alcohol will also produce similar results, if continued for a much greater length of time.

99. You mean it requires much larger doses?—Yes, it requires much larger doses.

100. Whisky may, of course, contain sensible quantities of amyl alcohol?—It may.

101. And, therefore, there would be a *primâ-facie* case why whisky should give peripheral neuritis and beer not?—That is so.

102. But you do not find that is the case?—I should not like to say that whisky does not produce peripheral neuritis. I am inclined to think that whisky does produce peripheral neuritis.

103. But I rather gather that you told us that from your experience in Manchester you had not been able to connect peripheral neuritis with the habit of whisky

drinking?—I was trying to explain, and I may not have put it clearly. It is generally considered that spirit drinking is the cause of peripheral neuritis, but we found in Manchester that although whisky is a cause, beer is a commoner cause than has been generally supposed, even before this outbreak occurred.

104. I think the word you used was that it was the "predominant" cause?—I think that is our experience in Manchester, that it is the predominant cause, but it is not considered to be so elsewhere.

105. (*Sir William Church.*) Do you say it is the predominant cause of the disease you have had going on in Manchester?—Yes.

106. (*Chairman.*) Is there any difference between peripheral neuritis and what may be called alcoholic neuritis?—No.

107. (*Sir William Church.*) Peripheral neuritis may arise from many causes besides alcohol?—That is so.

108. Or mineral poisoning?—Yes.

109. For instance, to use a common illustration, it is an exceedingly common sequela to diphtheria and other diseases, and therefore I would like the Commission to understand that alcoholic neuritis and peripheral neuritis are not necessarily one and the same. They are both peripheral neuritis, but there may be peripheral neuritis, as we know, arising from other causes besides either alcohol or mineral poisoning?—Quite so.

110. (*Chairman.*) Peripheral neuritis produced by alcohol may be called alcoholic neuritis?—That is exactly what it is.

111. (*Professor Thorpe.*) I think it would be desirable that we should get clearly on the notes, if Dr. Tattersall could give us the information, precisely what he learned on the occasion of his interview with Messrs. Nicholson's, as distinct from what he gathered in the course of the evidence. How long was your interview with Messrs. Nicholson?—I should think about an hour.

112. Could you summarise exactly what you learnt?—That they had made no change in the source of their pyrites during the then current year, 1900, at any rate up to June. I only asked up to June—I asked from January to June—that so far as they could then remember—and they were not at their works, and the books were not available—they had always delivered to Bostock's ordinary B.O.V., brown oil of vitriol. Bostock's, they explained, were very small customers, and they had no personal knowledge of them in any way. They could not remember any change having taken place during that year that could possibly account for the alteration. They knew perfectly well that the common brown oil of vitriol contained arsenic.

113. Did they say that they knew that that which they sent to Bostock's contained arsenic?—No, they said that their common commercial brown oil of vitriol contained arsenic.

114. Did they lead you to infer that was what they sent to Bostock's?—They did.

115. (*Sir William Hart-Dyke.*) How many years had Bostock's been their customers?—I was told at Bostock's that they had been customers for 20 years.

116. (*Mr. Cosmo Bonsor.*) Had they changed the price?—The price, I think, had been changed at times during that period.

117. (*Sir William Hart-Dyke.*) And had they supplied precisely the same type of material, as far as their knowledge went, in 1900, as they had supplied 19 years previously?—With the negotiations subject to legal proceedings at the present time one naturally does not want to say anything very definite. But it struck me that the negotiations were rather loose. There was a want of clearness of understanding between the two firms.

118. (*Professor Thorpe.*) That is what you have learnt subsequently?—Yes.

119. You had not learnt that on the occasion of your interview?—No.

120. Did they state to you that they had no knowledge of the use to which the sulphuric acid was put by Bostock's?—They did.

121. Did they know, to your knowledge, that they were sugar refiners?—I could not say that. It is difficult for me now to say where what I told them ends and where what they told me begins.

122. But you would inform them, I presume, that samples of invert or glucose taken from Bostock's had been found to contain arsenic?—I did.

123. And that it was supposed to be derived from acid they had supplied them with?—I did.

124. Was it known to them for the first time that invert and glucose was made by Bostock's?—They did state that they did not know what Bostock's used the acid for. They had no idea what that acid was used for.

125. Did they have any idea either that they were in any way connected with brewing or brewers?—I do not think they had.

126. (*Chairman.*) Or with glucose?—The impression they gave me—I think I should put it as clearly as possible—the impression they gave me was that they knew very little about Bostock's; that Bostock's were small, regular customers, taking a small quantity regularly from a large works, and they never troubled about them one way or the other, and they did not give much thought to it.

Acid out-put of Nicholson's

127. (*Sir William Church.*) They were taking from 7 to 10 tons a week?—But I think Nicholson's produce about 500 tons a week of acid.

128. For manure making, do you mean?—For all sorts of chemical processes. They assured me, and this was a point I thought I ought to enquire into, that they did not send any acid to the maker of any food product of any kind other than Bostock's, and they did not know then it was used by Bostock's for that purpose. I thought it was important to ascertain that at once.

129. (*Chairman.*) Did Bostock's manufacture anything else than glucose, or were they manufacturers of glucose alone?—At the time of my visit they were doing nothing but making brewers' sugars.

130. (*Professor Thorpe.*) I suppose you wish the Commission to believe that it is your own opinion that this epidemic is clearly traceable to the use of arsenic in the particular manufactory of sugar, viz., Bostock's?—That is so.

131. That you think it is solely to be attributed to that circumstance?—I do.

132. And that to that extent it is an accidental occurrence?—Quite so.

133. (*Chairman.*) The statement at the top of page 26 regarding Bostock's is derived from the coroner's inquest, is it not?—Yes.

134. And marks where the change to Nicholson's took place in March?—Yes.

135. You had been told they did not know of any change between the beginning of 1900 and the beginning of June?—That is so. This was the first time I had it explained to me why the epidemic began in June, a matter which had puzzled me very much.

136. Clearly the information you got from them was defective, but you do not attribute blame to them, because they said they had not full information at the time that you called?—Although I came away from their works with no information of any value to me, they did not give me the impression that they were deliberately withholding information.

137. Had they had their attention called to it before?—They said they knew nothing about it until I saw them.

138. (*Professor Thorpe.*) Had they not yet learned of the matter from Bostock's?—No. They could not very well, because I was at Bostock's for the first time at five o'clock on the Friday afternoon in Liverpool, and I was at Nicholson's on Saturday at noon. Bostock's did not believe it was their sugars at that time which were poisoning people—they could not believe my statement. They said they had made their sugars in the same way for 20 years, and it could not possibly be their sugars. Therefore I do not think Nicholson's had heard anything from Bostock's.

139. At that time had the public been alarmed about the epidemic?—It was already in the public Press.

140. Was it in the Public Press at the time you called on Nicholson's?—It was in the Manchester evening paper on the Friday afternoon. How it got there I do not know—it was stated that I had gone to Liverpool to a brewers' sugar makers' works to enquire into the cause of the epidemic, but I do not know whether Nicholson's knew of that or not.

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141. (*Mr. Cosmo Bonsor*). Where is Nicholson's factory?—In Leeds.

Beer drinking diminishing before cause of outbreak discovered.

142. What is the precise nature of the evidence you have as to the marked falling off in the consumption of beer—how did you learn that?—I learnt that from the brewers. One of the brewers told me that he had had a falling off in the consumption of his beer, and that he had enquired from other brewers if they had had a similar falling off, wondering whether something had gone wrong with his beer. He told me at that time that he had received information from other brewers that they had had the same experience.

143. Was that a brewer using Bostock sugar?—It was.

144. Were the other brewers to your knowledge using Bostock sugar?—Not all of them. That is the only source of my information.

145. That particular brewer?—Yes.

146. Did he say anything of the other brewers?—He told me in general terms that other brewers in the district had had a similar experience.

147. Did he mention their names to you?—He did not.

148. You had no knowledge then that they were using Bostock sugar?—A number of them were.

149. (*Chairman.*) When he told you of this falling off had you let him know that there was this scare?—He knew then that there was something wrong with the beer, and that the beer was doing harm, because I had told him, but we did not know then that there was arsenic in the beer. It was before that was discovered.

Increase in Bostock's business after 1896.

150. (*Professor Thorpe.*) What is the basis for the statement that in 1895 Bostock's, who then became a limited company, pushed their business much more energetically in the districts of Salford than before?—I have ascertained that a brewery which since 1896 has used as much as 300 and 400 tons a year of Bostock sugar, prior to October, 1896, did not use any from Bostock's.

151. Have you had your attention as a medical man called to the possibility of this disease being attributable to something else than arsenic?—One had a good many possibilities to consider at first. I approached this thing purely from the public health standpoint; that is, a number of people were ill, and I enquired into all the circumstances, and I found one thing in common, viz., that they drank beer. Samples of that beer which they drank were found to contain arsenic—samples obtained in the ordinary course of trade from public houses from which a particular class got its beer was found to contain arsenic. Arsenic accounted for the symptoms, and I was satisfied without going any further. The arsenic was in sufficient quantity to account for the illness.

Sicilian sulphur should be used in manufacture of acid used for food.

152. You specially indicate, as one method by which you think the recurrence of a calamity of this kind would be avoided, that all sulphuric acid which is used for the manufacture of food products, or all sulphuric acid which is in any way concerned in the preparation of food products, should be made from a single source, viz., native Sicilian sulphur. That is, I think, your recommendation?—That is so.

153. Are you aware, however, that it is not difficult to prepare perfectly pure sulphuric acid even from pyrites acid?—I am quite aware of that.

154. Would not the fact of limiting the production of sulphuric acid to what you call native Sicilian sulphur have the effect of very considerably enhancing the price of sulphuric acid so formed, without any very obvious advantage?—It seemed to me that, in the first instance, the preparation of sulphuric acid used for food purposes in comparison with the total amount of sulphuric acid used, is exceedingly small. It is only a small portion of the trade. I thought it was advisable to err on the side of safety. The fact that you can produce a perfectly pure sulphuric acid from pyrites I know quite well, and that such acid has been used in the preparation of this glucose and inverted sugar by some manufacturers without any injurious results I also know. But it seems to me that it ought to be impossible, as far as it can be made so, for a mistake to have any serious results. The sulphuric acid manufacturers, as a rule, do not make simply de-arseniated acid, but they make and sell for various trade purposes a much cruder acid, which is perfectly good for those purposes. It is certainly possible, to say the least, that a mistake might easily be made by a workman, because the carboys are packed and sent off by unskilled men, and there is nothing in the appearance of the acid that can make anyone certain it either does or does not contain arsenic. It might be sent off and used by ignorant persons, to the serious detriment of the public health. I thought it was better to err on the side of safety, even if the price of acid for the particular purpose was somewhat increased.

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155. Are you aware that there are other sources of supply of native sulphur than Sicily?—Yes, there are.

156. And it is also the case, is it not, that even native sulphur may from time to time contain small quantities of arsenic?—It does, I believe.

157. Therefore, if anybody were to solely rely on native sulphur as a criterion of purity of the acid, they might occasionally be mistaken?—They might get acid with some arsenic in it, but they could not get acid with much in it, not enough to do any harm.

158. Inasmuch as pure sulphuric acid can be made by proper treatment from pyrites, is not the real remedy not to prescribe that a certain form of sulphur should be used, but that a person using the acid shall be assured of its purity by analysis before he takes it into use?—That was presumed to be done in this case, and it shows you how easily that sort of guarantee breaks down. It is to guard against the breaking down of machinery of that kind that I suggest the other remedy. If a man has a works in which he uses nothing but native Sicilian sulphur for the production of acid, which is done, I believe, in some cases, it is an easy matter for the purchaser, if he so desires, to go to that works and see the sulphur on the premises being used in the production of the acid, and he cannot, no matter whether the acid be made strong or weak, whether it be made colourless or left coloured, get an amount of arsenic in that acid which is going to do much harm to his food stuffs.

159. Are you aware that other invert sugar makers or glucose makers use exclusively the oil of vitriol from pyrites or from native sulphur?—I know one firm of sugar makers who use entirely what is guaranteed to them as made from native sulphur. I know another firm who use the pyrites acid only, and other firms, I believe, sometimes use the one and sometimes the other, the main point being that it is guaranteed free from arsenic and that it is watched. It is that watching process that may break down, and that has broken down. The man who buys nothing but Sicilian acid, whether his watching process breaks down or not, is not going to damage the public.

160. Is there any evidence that those other makers of invert sugar or glucose have delivered their product contaminated with arsenic?—Not at all.

161. I think you said that you imagined this was a purely accidental circumstance in the case of Bostock's?—Yes.

162. How many invert sugar or glucose makers are there, to your knowledge?—I know of five.

163. Do you know of any instance in which they have delivered arsenicated products?—I do not. There are traces of arsenic in some of the sugars besides Bostock's, only they are traces that could not possibly account for any damage.

164. In your opinion, negligible traces?—Negligible traces.

165. Not more than would be contained in the malt?—Quite so.

166. Presumably in those cases the invert sugar or glucose makers have safeguarded themselves by analysis?—They presumably have.

167. (*Sir William Church.*) I think that you are a medical officer of health; you are not an analytical chemist by profession?—That is so.

All implicated brewers used Bostock's sugar.

168. Might I just ask you one other question? I suppose you have satisfied yourself that all the brewers who are on this list were supplied with Bostock's sugar?—I have. In two of the instances, the two where the largest number of cases are concerned, I found Bostock's sugar on their premises, and had it analysed. In other cases I have Bostock's assurance in each case that they had supplied these people. In two or three of them it has come from the brewers themselves in evidence at the various inquests that they did use Bostock's sugar, and one or two others I know personally from the brewers themselves in addition. So that I have two sources of knowledge with respect to every case.

169. (*Mr. Cosmo Bonsor.*) I suppose you have no sort of evidence as to how this sugar was used; whether it was used in the process of brewing or for priming?—It was used for both.

170. Have you the knowledge where it was used for priming rather than the ordinary process of brewing, that there were more fatal cases?—I have only one case where it was used for priming, and in that case they used it very largely in the other process as well, so that we got a double dose there.

171. The object of my question was rather to find out if you could tell the Commission whether the process of brewing with the sugar would not more or less destroy the arsenic that might happen to be in it?—It does, as I indicated. The process of brewing, I believe, does take out a certain proportion but it by no means takes it all out.

172. It would reduce it?—Yes.

173. And consequently it would reduce the risk if the sugar was all used in the brewing rather than used in the priming?—Yes, it would.

174. (*Professor Thorpe.*) Have you any idea how it would reduce that risk?—In the first place healthy non-arsenicated yeast takes up arsenic from arsenical wort, and that would take some out. Then again, some is deposited on the coppers and in the other processes, because the scrapings from the vessels have been found to contain traces of arsenic.

175. In the wort from which the arsenic has been abstracted by the yeast, would the wort have had the hops added to it?—Yes, it would.

176. Might not those hops have been sulphured hops?—They very often are.

177. Would not the fact of the sulphur in the hops tend to precipitate the arsenic as arsenic sulphide on the yeast?—It might, I cannot say.

178. Arsenic sulphide is a highly insoluble substance, is it not?—I believe it is.

179. (*Chairman.*) Would not arsenious B.O.V. be dangerous if used to prepare manure, for example, put on a turnip crop?—That is a thing I cannot say. The fact that vegetable crops do take up arsenic from the soil has been known for a great length of time. We have found a sample of barley with arsenic in it. That soil had been manured with manure that there is reason to believe contained arsenic. But I do not think any of these substances contain enough arsenic to do anyone any harm. That is simply an opinion.

180. (*Dr. Whitelegge.*) Can you say how many breweries there are in Salford?—Five.

181. Five altogether?—Yes.

182. How many of those do you regard as being supplied with Bostock's sugar?—Two.

183. The action that you told us of was taken mainly with regard to the breweries in Salford, was it?—Yes, mainly.

184. Did you communicate with the breweries outside Salford supplying Salford?—No, I communicated with their houses in Salford.

185. You told us of a large amount of beer being destroyed: is that beer from breweries or from public-houses, or from both?—That beer is from breweries only. There has been a large amount destroyed in public-houses, but I have no record as to the amount, and consequently I cannot include it. The amount there stated is a minimum, but there was more destroyed, although I do not know how much more.

186. Has any attempt been made to form an estimate of what I may call the beer drinking population?—There has not. It seemed to be impossible to get information of that character that was reliable.

187. Is it your general conclusion that the liability to arsenic poisoning of this kind has increased in proportion to the consumption?—I could scarcely say that. I think it increases more with the personal susceptibility of the individual.

188. That also; but from what you have read to us (Q. 8. p. 5) I drew the conclusion that although a large proportion of the cases were among small drinkers, yet presumably the small drinkers, although we have no exact figures, would be so much the larger population, that the case incidence would be relatively larger than in the other class?—Of course, the case incidence is presumably much heavier. In fact, I think from these figures the case incidence is heavier with the heavy drinkers, but the other factor is one that must not be lost sight of, the personal factor.

189. That you made very clear?—Yes.

190. Have you thought of any other predisposing condition? You told us something about class; you do not think it was only the poorer class that was affected?—I do not.

191. Although your figures are more complete for that class?—They are.

192. As to sex, I understand from you the incidence is greater amongst women?—Yes.

193. Can you tell us with regard to the chart of deaths from peripheral neuritis (*Appendix No.* 1), what the sex distribution was in earlier years?—I cannot.

194. Could you find it out?—I could very easily ascertain.

195. Are there any industries carried on in Salford likely to cause arsenical poisoning in such a degree as to affect the result shown here?—Not to my knowledge.

196. Have you personally seen the cases?—I have seen a large number of them.

197. Could you tell us whether any of them were in a debilitated condition?—The cases that I saw when in bed were wasted and in a terribly weakened and debilitated condition.

198. From the disease?—From the disease.

No relation of poisoning to influenza or antecedent debilitating conditions.

199. But you had not any evidence pointing to debility as a predisposing cause of attack?—No. The history in many cases, especially in the males—has been the history of a healthy person suddenly becoming ill, and rapidly developing the various symptoms, which Dr. Reynolds describes better than I can do, of this particular poisoning.

200. The suggestion has been made that influenza as a debilitating condition might predispose. Have you any information on that?—I have no reason to think there has been any particular amount of influenza in Salford, any unusual amount, for some time.

201. When was the last epidemic in Salford?—We have had deaths referred to it for the last three or four years; but prior to that it was much heavier than it has been since.

202. You have had it in Salford each year?—Yes, each year.

203. In the early part of the year?—Yes.

204. Including 1900?—Yes.

205. By whom were the particulars of these cases obtained and analysed?—Some of the particulars were obtained by myself, and the rest were obtained by my chief inspector personally.

206. From the patient, or from the practitioner?—From the patient, from the patient's friends, and from the practitioner. Every means of information were used.

207. Had you a form which you used for the purpose?—I had.

208. Have you a copy with you?—I have not, but I will let you have one.

Extent and fatality of epidemic.

209. In applying to the practitioners for information, for what did you ask them—for the names or for the numbers concerned?—I asked for either, names where they did not object to my describing the cases, and numbers or letters where there was an objection.

210. Can you tell us how many practitioners there are, and how many gave you returns?—I cannot tell you exactly, because we have a large number of practitioners who do not live in Salford but practise largely in Salford.

211. But roughly?—I should think roughly we have about 100 practitioners, and about one-third of them gave me returns.

212. Did you obtain returns from all the public institutions?—I did.

213. On page 9, if I follow you rightly, you have included cirrhosis cases among those which may be properly referred to arsenic?—Yes.

Fatal cases of cirrhosis of liver, chronic alcoholism, and cardiac failure in relation to poisoning by arsenic in beer.

214. And are those cases in which the cause of death is stated on the certificate as cirrhosis, without any mention of arsenic at all?—Yes. I had better explain exactly the way I have used these certificates. The diseases certified have been peripheral neuritis, alcoholism neuritis, multiple neuritis, or chronic alcoholism. There may have ben such things as cardias failure, or something of that kind following,

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but the certificates have obviously meant that and nothing else. In many of the cases of cirrhosis of the liver, peripheral neuritis has been mentioned as one cause of death, but it has been classed as cirrhosis of the liver in order that there should be no increasing of the deaths from peripheral neuritis unduly.

215. But still you think of the cirrhosis cases as properly belonging to the same group?—Some of them.

216. And caused in the same way?—Some of them. I think it is fair to look upon the exceptional increase in cirrhosis this year as being due to this cause.

217. As being due to the same cause that brought about the exceptional increase in peripheral neuritis?—Yes.

218. How long would it take for a case of cirrhosis, assuming it to be so caused, to prove fatal? You see what I am coming to. I am going to ask you how you associate the increased tendency to arsenical poisoning which is supposed to have arisen in the earlier part, or the middle part, of 1900, with cases of a long-continued disease like cirrhosis terminating fatally in the same year?—I associate it in this way. That one of the symptoms of many of these arsenical cases has been anasarca, and in many instances, certificates of death may be given without very careful investigation; that judging from the general symptoms, the fact that people were said to be drinkers, that anasarca was present, and that the liver was hypertrophied—I think I should refer here to the fact that post-mortem examinations have shown hypertrophied livers in these cases where there has been no amount of alcohol taken to account for that hypertrophy—taking those things into consideration, I take it that cases have been certified as due to cirrhosis of the liver when really they were due to arsenical poisoning. I think it is a mistake in the certificate.

219. Do you mean that there was no real cirrhosis, or that the liver was in an initial stage of cirrhosis only?—Dr. Dixon Mann found that in cases where the evidence showed that no large amount of alcohol had been taken, but that arsenic certainly had been taken, the liver was hypertrophied, and that that hypertrophy was due in his opinion to the arsenic. I think a practitioner in a case where he had a hypertrophied liver and anasarca, and was told that the patient was in the habit of taking drink, might very easily certify the death to be due to cirrhosis of the liver.

220. Do you regard that condition of enlarged liver as an early stage of cirrhosis?—That I cannot say.

221. Later on you mention that there were 107 fatal cases?—Yes.

222. That would correspond to a much larger total than 996?—That is so.

223. You have not seen your way to make any estimate of the total number of cases from the number of fatal cases?—I have not.

224. Can you tell us how many out of the 996 known cases proved fatal?—They include every one of the fatal cases, except the 22 due to cirrhosis of the liver, which have not been included in that 996.

225. On page 8 of your report you mention a certain number of slight cases; are those included in the 996?—They are not.

226. Is the diagnosis of peripheral neuritis one that is readily made by an ordinary practitioner?—Certainly, in its more advanced stages.

227. And the diagnosis is improving, I suppose?—Yes.

Earlier cases less severe.

228. Have you any explanation of the circumstances that the early cases were slight? You mentioned that as a fact I think?—I know it is a fact that the slight cases were common early on, but the explanation is not quite so easy. I am inclined to think that this epidemic shows what we did not think before, that arsenic is a cumulative poison to a much greater extent than we believed. I think that is one of the lessons of the epidemic.

229. And I suppose that possibly the beer earlier on contained less arsenic?—I do not think there is any particular reason to think that.

230. Did the analyst to whom you refer at page 28 receive any samples of beers brewed from Bostock's sugar?—No. We thought he might have done so, but he did not as a matter of fact.

231. Were the samples submitted to Professor Delépine taken formally or informally?—Informally.

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232. Could you say that any sample that was tested was identical with one believed to have caused the mischief?—The samples which are marked on the Table A were obtained on the 16th of November from the shop from which a woman who had been ill, and who had been prosecuted for neglecting her children, and allowing one to die, obtained her beer. She had been found to be suffering from such mental disturbances that she could not be tried, and a subsequent investigation of her case showed it to be one of these arsenical poison cases. It was clearly one of the cases of illness that was then going about, and it was proved in evidence before the coroner's court at that time that she got her beer from this particular shop. I immediately went and obtained the sample A from that shop.

233. It might have been a later supply?—It might have been a later supply.

234. (*Professor Thorpe.*) But I suppose you had under observation a number of the employés in the brewery?—Yes, they certainly used that beer, but we do not know that they used it exactly at those dates.

235. (*Dr. Whitelegge.*) You mean this particular lot of beer in question?—Yes.

236. What are your statutory powers in relation to a matter of this kind?—They are limited to our powers under the Foods and Drugs Act.

237. And the Public Health Act?—I could scarcely say without reference.

238. Is it part of your official duty to take charge of the administration of the Sale of Foods and Drugs Act?—It is.

239. Under what instructions?—Under the instructions of the Town Council.

240. Are they formulated?—I could not say. I have never had any definite instructions other than those contained in the Local Government Board regulations; but there is a resolution on the minutes of the Health Committee directing me to conduct prosecutions under the Food and Drugs Act.

241. And to obtain samples?—I have a special inspector, who is appointed for that purpose, who does nothing else but take samples.

242. What number of samples roughly are taken in Salford in the course of a year?—On the average 750.

243. Do you instruct the inspector what samples to take?—I do.

Samples of beer sold taken for public analysis under F. Acts.

244. Has he in former years taken samples of beer?—Up to 1897 he pretty regularly took beer. But in 1897 beer was stopped being taken, because it was found always to be right. The only impurity with which we had to deal was the question of adulteration with water, and it was scarcely worth while taking samples for that.

245. Were the samples of beer taken sent to the analyst simply for analysis, without instructions?—Yes.

246. And was the analyst's certificate to the effect that they were free from adulteration?—Yes.

247. You do not know, I suppose, what the analyst looked for?—No, I do not.

248. Do your instructions from the Local Government Board contain any reference to the administration of the Sale of Food and Drugs Acts?—Not that I remember.

249. Do you make any report?—Yes.

250. I mean any report specially on this, or is it part of your annual report?—It is part of my annual report.

251. I believe the Local Government Board, after the occurrence of this epidemic in Manchester, issued a circular, did they not?—Yes.

No Government instructions as to administration of Food and Drugs Acts generally.

252. Have you had other memoranda or instructions dealing with the administration of the Sale of Food and Drugs Act from any Government authority?—Not to my recollection.

253. In the action that you took under the Sale of Food and Drugs Act in relation to these cases, did you go to the retailer for samples?—Yes.

254. What quantity was taken?—A quart was obtained in each case.

255. And that had to be divided into three?—Into three parts.

256. Did you prosecute any of the retailers?—We commenced a prosecution, and it is still hanging over two retailers who sold beer that contained 1-200th grain of arsenic per gallon.

257. What would be your powers in relation to the brewer, and, let us say, a chemical manufacturer who supplied some of the material which passed through the brewery to the retailer?—As far as I have been able to gather, we have no powers to go past the retailer. We can punish the retailer, and the retailer can protect himself under a guarantee from the wholesale dealer, and then we can get at them; but apart from the question of a guarantee we cannot do it.

258. You cannot do it without a guarantee?—We cannot go past the retailer then.

259. (*Professor Thorpe.*) Have you no power by magistrate's order to go into a brewery and order something you know to be bad to be destroyed?—Yes, if we knew it to be bad. In that way it might be dealt with.

260. (*Dr. Whitelegge.*) Under what statute?—On the question of the food being unfit for consumption—the Public Health Act, but as a matter of fact it was never necessary to exercise any powers. We simply requested, and all that we desired was carried out.

261. If there is no warranty, do you consider you have no means of approaching the wholesale dealer or the manufacturer?—I do not think I have.

262. Have you any experience of cases in which action has been taken on warranty?—I have not.

263. Would it be a convenience if the wholesale dealer or manufacturer could be associated in the case?—A very great convenience. It would save trying the case twice over for one thing.

264. And would it be an advantage that the person accused should have an opportunity of challenging and verifying the analysis of the original sample?—Yes.

265. There are other destinations of glucose, and I think you told us you have been looking into these in Salford?—Yes.

266. Has that been the practice in former years?—In what way?

267. The destinations of glucose other than beer—I mean the manufacture of some kinds of sweets?—We have taken samples of sweets prior to this outbreak.

268. Officially?—Yes, and at odd times we have taken samples of all kinds of substances.

269. You make certain suggestions at the end of your report as to provisions for the safety of the public. With regard to paragraph on page 38, what exactly did you think of as being the proper duties of the inspectors under the Central Government?—I take it that the works are practically under the supervision of the inspectors under the Alkali Acts. These inspectors visit these works, and it is a very easy matter when an inspector visits the works to see what is going out, and if it is not labelled as containing any poison, to take a sample and submit it to the Government analyst.

270. And would you extend that, not merely to any scheduled substances, but to all substances?—It is exceedingly difficult to define. Perhaps in the first instance it might be extended to scheduled substances. I do not see why a wholesale chemist should send out poison any more than a pharmaceutical chemist, unless it is labelled.

271. Then in paragraph 5, at the foot of page 38, you say "The Food and Drugs Act should also be amended so as to make the contamination of food stuffs with poisons in appreciable quantity, whether to a dangerous extent or not and whether to the knowledge of the seller or not, an offence within the meaning of the Act"?—I take it that an appreciable quantity would be what a chemist would consider a quantity that could be properly, and definitely recognised as a weighable quantity.

272. Do you mean a quantity that could be recognised by any test?—Not quite. I can conceive that tests might become so delicate that most minute quantities—what are often classed as traces—might be defined.

273. Are you prepared to suggest any limit from the medical point of view below which arsenic is immaterial?—In beer I do not think that any arsenic below 1-100th of a grain per gallon could do any harm.

274. Even in the extreme cases of which you gave us an example?—I do.

275. Where 1-50th of a grain produced symptoms?—Yes.

276. You would not think the habitual consumption for a long period of beer containing 1-100th of a grain per gallon would be harmful?—You see one-hundredth of a grain per gallon means one-eighth hundredth of that per pint.

277. I only want to get your opinion?—That is my opinion. I will put it perhaps rather in another way, that nothing more than 1-100th should by any possibility be allowed.

278. (*Chairman.*) Has there been prosecution of retail sellers for 1-200th per gallon?—There have been cases, but they have not been gone on with yet. We are awaiting the decision on the Manchester cases, and at present they are under adjournment. But it does seem advisable if the prosecution should take place on those lines for a legal definition to be obtained as to whether a person is legitimately allowed to sell beer containing 1-200th of a grain per gallon.†

279. (*Dr. Whitelegge.*) In your report you suggest an extension of the system of notification, do you not?—Yes.

279*. Will you tell us how you would think of applying it in a particular instance—what sort of schedule of notification you would use?—I feel confident that if this return from the Poor Law officials had been regularly sent to the medical officers of Manchester, Liverpool, and to myself, we should have noticed what one individual medical man may not have noticed, but which coming from several would have become more pronounced, a very distinct increase in the cases of peripheral neuritis, and that would in the natural course of events have caused us to enquire, and enquiry could not fail to have elicited the fact.

280. You are thinking rather of a complete return of all cases of pauper sickness?—Yes.

281. That comes later on in the suggestions, but I understood you to mean something rather different at this point?—The ideal condition to my mind is a universal notification of disease.

282. Of all diseases?—Yes, all diseases. But failing that I think it should be generally understood by the profession to a much greater extent than it really is, that there is machinery already provided for an enquiry into the causes of death, and that where sickness either unusual in character or unusual in amount occurs it should be reasonably expected that the practitioner should communicate with the authorities.

283. You mean an understanding rather than a statutory duty?—I cannot see how it could be made a statutory duty unless you were prepared to do the whole thing, and have what I believe is actually in existence in other countries—a universal notification of disease.

284. In this particular instance you would not have been able to formulate beforehand peripheral neuritis as a disease requiring to be notified, would you?—No.

285. Then, coming to your further point in the paragraph at the foot of page 39, Dr. Buchanan points out that that is hardly correct. Under the third article of the Order of the Local Government Board under which that duty arises, the words are, "Every medical officer appointed by the guardians after the 28th day of February, 1879, whether for a district or workhouse, shall immediately upon the occurrence of any case of contagious, infectious, or epidemic disease of a dangerous character amongst the pauper patients under his care, give notice thereof to the clerk of the sanitary authority of the urban or rural sanitary district as soon as may be, within which he acts as medical officer, or to the medical officer of health of such authority"?—If you read the order you will find further on that the clerk of the authority——

286. There is a further power, but it is optional with the Local Government Board, and they have not yet exercised that option?—That I did not know.

287. The suggestion is equally good either way?—Yes.

288. (*Chairman.*) Turning to the question of 1-200th grain per gallon, in certain cases in which prosecutions have been commenced, by whose test was the 1-200th grain in a gallon found?—The Reinsch test.

289. What quantity of the liquor was used?—A third of a quart. I cannot say of he used all that third, but that is the quantity he had supplied to him.

† Note.—An appeal on the cases in question was heard on May 13th, 1901, in the High Court, King's Bench Division (Goulder *v.* Rook; Bent *v.* Omerod; Lee *v.* Bent; Barlow *v.* Noblett).

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M.O.H and outbreaks of non-notifiable disease.

Tests for arsenic applied to Salford beers.

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290. Is not that rather a small quantity to ascertain the facts when it is a question of a 1-200th of a grain in a gallon?—We found that when toxicological methods of enquiry are used, and proper care is taken—I have the exact quantities here—that from 50 cubic centimetres of beer you can ascertain 1-6th of a grain per gallon.

291. 50 cubic centimetres have sufficed to show the presence of 1-6th of a grain per gallon?—Yes.

292. Then surely a third of a quart would be a very small quantity of the liquor to show 1-200th of a grain per gallon?—1-200th is a very small quantity, of course. We have used in most of our analyses from 150 to 200 centimetres, and we have found no difficulty in demonstrating exactly 1-70th of a grain per gallon in that quantity.

293. Is it not the case that Professor Delépine has found considerably larger quantities than have been found in the same sample by public analysts?—That I cannot say. He found large quantities in the same samples that had been submitted to public analysts who did not find any, but for the simple reason that they never looked. They never attempted to find any.

294. Is Reinsch's test capable of giving quantitative results accurately?—I think so; that is the opinion we have come to.

295. Has Marsh's test been largely used?—We found very early that Marsh's test as used with beer is more difficult to work, and, in many ways, not very satisfactory, and we have confined ourselves to Reinsch's test.

Powers of M.O.H. under P.H. Act and F. & D. Acts.

296. (*Sir William Hart-Dyke.*) I am anxious that we should get it on our notes, and I would ask you to tell the Commission what you understand to be your statutory powers as a medical officer for the protection of the public health?—I can take samples——

297. Under what Act? There is the Public Health Act and the Food and Drugs Act?—They are the two Acts.

298. Are those the only two?—They are.

299. With regard to notification of disease, such powers as you exercise would be under the Public Health Act, I presume?—They would.

300. But under the Public Health Act have you any power whatever to go into a brewery and inspect the beer or test its quality, except when you have very strong evidence indeed that that beer being sold is very injurious to the public health from some cause or other?—No.

301. In that case, if you have strong evidence that poisonous substances are contained in it you have full power to examine and test the beer, but not otherwise?—Yes, but not otherwise.

302. With regard to the Food and Drugs Act, you have no power whatever for testing the quality of the beer, have you?—We can take samples of beer under the Food and Drugs Act, certainly.

303. How you like and when you like?—Yes, from the retailer.

304. But only from the retailer?—Yes.

305. And as regards the retailer, you have full powers to examine and test at all times?—We have.

306. And under all circumstances?—We have.

307. But not as regards the brewer?—No.

Powers of M.O.H. to enter Brewery

308. (*Professor Thorpe.*) With respect to that, is it not the fact that supposing your public analyst had reported that a certain sample of beer purchased in the manner you have described under the Food and Drugs Act was found to be largely contaminated with arsenic, and you had the strongest possible evidence connecting that retail sample with the brewery, you could get powers to enter that brewery and order the destruction of that liquor?—I think under the Public Health Act I might. I have not tried to do so. The question has never been fought to my knowledge whether one could or could not, but I believe I have such powers.

309. (*Dr. Whitelegge.*) The powers in question would be powers of seizing in the same way that you seize food unfit for consumption?—Yes.

310. That is to say, you would seize it provisionally, and obtain an order from a magistrate?—That is so.

311. In what light do you regard the Sale of Food and Drugs Act, as a means of checking adulteration or as a means of preventing damage to the public health?—I have looked upon it entirely up to now as being a check upon adulteration.

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F. and D. Acts mainly a check on harmless adulteration.

312. Which I suppose would be largely harmless adulteration?—Yes, almost entirely harmless adulteration. I believe there have been some successful prosecution in Liverpool under the earlier sections of the Act, but they have not been often used. I have never used them, and had no occasion to use them. When samples are taken under the Food and Drugs Act, and submitted to the public analyst, the public analyst examines the food submitted on the question of adulteration purely.

313. Has he no instructions to guide him in that matter?—No.

No central instructions to Public Analyst.

314. Has nobody attempted to formulate for the guidance of public analysts what the dangerous substances are that may be found in particular foods, or in what way he is to examine them?—Not to my knowledge.

315. (*Chairman.*) Do you think more safety could be had for the public by giving instructions to public analysts to find more than merely adulteration; that he should be expected to find for himself anything deleterious?—At present the public analyst is an outside servant of the corporation—he is not entirely employed by it, and usually he is paid either a retaining fee and so much a sample, or a fee per sample, and for him to be expected to do work which must be more or less of an investigating character would be unreasonable. It would be unreasonable to ask him on the ordinary scales of remuneration to examine, say, a sample of beer for all known poisons. It would take him a long time, and necessitate a great amount of labour, and to pay him the 2s. 6d. fee for an examination of that sample would be ridiculous.

316. (*Dr. Whitelegge.*) Would you expect a public analyst, without any further instructions, to examine for arsenic any sample of beer that came to him officially?—No, I should not.

317. Even in the face of the recent epidemic?—He probably would.

318. But you think it would not be a reasonable requirement in general?—I think he would be much to blame if he did not under the present conditions.

319. (*Chairman.*) Do you not think an amendment of the law or regulations respecting public analysis might be desirable, that there should be grades of investigation, an ordinary investigation, under a 2s. 6d. fee, or a more thorough analysis and a corresponding payment?—Yes, I think, as I say here, that the earlier sections of the Food and Drugs Act should be amended to make it more possible to get at the offenders in cases where deleterious substances have found their way into articles of food, and that analyses taken under those sections should be paid for under a different scale, and in a different manner from ordinary analyses for adulteration.

320. (*Dr. Whitelegge.*) Who do you suggest should decide between the one kind of analysis and the other?—I think it would be a proper thing for me to take samples for any specific purpose, and samples could be submitted to the borough analyst for one purpose or the other, or possibly for both.

321. The decision should rest with the medical officer of health?—Yes.

322. (*Professor Thorpe.*) But your local powers are quite sufficient to enable you to do that now?—Quite so.

323. You do not want fresh legislation to enable you to do that?—No. Only when the analyst has made his examination, and found the deleterious substances, I shall be able to get at the person who sold the article.

Effect of Warranty obtained by dealer.

324. Do you mean the wholesale seller?—Either wholesale or retail. The retailer, if he has not protected himself. A retailer under the Food and Drugs Act can always protect himself by a warranty.

325. Are you not aware that in the Act of 1899 there is machinery to connect the wholesale man with the retailer, if the prosecutor chooses to set it in motion? I do not recollect those provisions of that Act.

326. Under the amended Food and Drugs Act 1899 the Court can order the wholesale man or anybody who has been connected with the distribution of the food in England, to be associated with the party who

is charged in the indictment?—That is a power of the Court, not of the prosecutor.

327. The prosecutor can do it—the town clerk can do it?—I do not remember that.

328. (*Chairman.*) I suppose he acts on behalf of the Committee, and merely does it on the part of the Committee?—Quite so.

329. I think you told us additional legislation would be needed to allow those responsible for the public health to put more work on the public analyst than is at present put upon him?—I think under the earlier sections of the Food and Drugs Act, which deal with deleterious substances which may get into food, there is no offence unless you can prove that the person implicated had actual knowledge that it was there, and it is almost an impossibility to prove that. My contention is that that question of knowledge should be done away with, and that if deleterious substances are found, the person who sells the article, or the wholesale dealer, if he can be either associated with him or made responsible by warranty, should be prosecuted, whether he knows, or whether he does not know. If he does not know he must take proper precautions in the course of his business to get to know.

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330. And for that purpose would an amendment of the law be required?—It would.

331. In respect of a public analyst, I understand now that no additional legislation is required in order that you may give more work to him, and pay him accordingly. You can give him more work and pay him under the present Act?—The way in which the analyst does his duty is simply an arrangement between the analyst himself and the corporation that employs him, and that could be arranged. There would be no difficulty with regard to that, so far as I know.

332. So that what you want in the way of legislation is something to the effect of fixing the responsibility?—That is so.

333. (*Chairman.*) The Commission is very much indebted to you for the evidence, the valuable information, and the expressions of opinion which you have given, and I desire to thank you in the name of the Commission.

Dr. Ernest Reynolds, called; and Examined.

Dr. E. S. Reynolds.

334. (*Chairman.*) You are, I believe, Assistant Physician to the Manchester Royal Infirmary and Visiting Medical Officer to the Manchester Workhouse Infirmary?—Yes.

335. Can you give the Commission information as to the symptoms found in the condition commonly called alcoholic paralysis?—In this condition, which has been called for many years alcoholic paralysis, there are certain sensory disturbances, quickly followed by certain motor disturbances, certain heart symptoms not infrequently, and also not infrequently certain quite peculiar mental symptoms. The sensory symptoms consist principally of prickings and burnings in the hands and feet, and cramp in the calves, and they are associated with a very exquisite tenderness, which is found on pressing or squeezing the muscular mass between the fingers. That peculiar tenderness is found in very few other conditions; as far as I know, it is only found in the so-called alcoholic paralysis, in arsenical paralysis, and I believe, although I have not seen cases, it is found in beri-beri, a tropical disease. I am also informed, although I have not seen cases, that occasionally it is seen in the paralysis following diphtheria. As regards the motor symptoms, these consist of gradual loss of power in the feet and hands, the loss of power being due largely to an inflammation of the nerve trunks in the limbs, or, in technical language, peripheral neuritis. This loss of power is so peculiar, that a peculiar form of gait is produced; the person always walking, or nearly always walking in a way which is more or less typical of the affection. At the same time the hands become paralysed and drooping, and in many cases in the advanced stage the diaphragm becomes paralysed, so that there is very great difficulty in breathing. At the same time, in many cases you have a dilatation apparently, or at any rate, a failure of the muscle of the heart, so that you get breathlessness and dropsy of the feet. In some cases you get the peculiar mental symptoms which I have just mentioned, these mental symptoms consisting of a very characteristic loss of memory of time and of place, so that a patient does not know at all how long he has been in the wards. If patients have been lying paralysed, say, for three or four months, and you ask them where they were yesterday, they will probably tell you they have been out for a walk. Many of them are quite incapable of saying where they are. They think they are somewhere else, and they will tell you that that morning they have been for a walk somewhere or other. Those are the symptoms we have known now for many years, and such cases, as far as I can tell, are very common in Manchester; very common in the years 1887 to the end of 1899 at the Manchester Royal Infirmary. I take these figures, because they are more available than the figures at Crumpsall, which is a larger place, where we have not proper help to get out such figures. But at the Manchester Royal Infirmary, where they have 1,500 medical cases admitted every year, the average number of alcoholic paralysis cases from 1887 to the end of 1899 was 20.

336. Twenty annually?—Yes. So that the cases are really quite common in Manchester.

337. Are these cases more common in Manchester than elsewhere, so far as comparison can be made?—As far as I can hear, I think they are more common in Manchester than they are in many other parts at any rate. They are more common in Manchester, I think, than they are in Scotland, and I am inclined to think that they are more common proportionally in Manchester than they are in London, but I cannot speak positively of that.

338. (*Professor Thorpe.*) How do they compare with Liverpool?—I think they are about the same.

339. (*Chairman.*) Do you attribute that to a greater consumption of alcohol in Manchester than in London or Scotland?—No, certainly not than in Scotland.

340. Still, you would call it properly alcoholic paralysis?—That is what it has always been called. I wish to say more about that in a moment or two.

Chronic arsenical poisoning

341. Can you say anything about the symptoms generally found in chronic arsenical poisoning as known previous to the present epidemic?—In chronic arsenical poisoning you get, as a rule, first of all, digestive disturbances, vomiting and diarrhœa. You next get symptoms of a cold in the head, running of the eyes and the nose, and frontal headache. About this time you get in not a few cases peculiar acute rashes on the body; rashes like measles, sometimes like scarlet fever, and rarely, but well described, herpes or shingles. You then get marked sensory disturbances exactly resembling the sensory disturbances I have just described as occurring in alcoholic paralysis. Then you get motor disturbances almost exactly the same as I have already described in alcoholic paralysis. I have now seen a considerable number of arsenical cases, and I have seen a large number of alcoholic cases before this outbreak, and I cannot differentiate between the sensory and motor symptoms of those occurring during the present epidemic and those which I have seen previously, taking the cases altogether. You also get in chronic arsenical poisoning, later on, certain chronic skin affections marked by a peculiar pigmentation of the skin, and by a peculiar thickening of the palms of the hands and the soles of the feet. I ought to have said in acute skin affections you also get, with the burning, a very marked redness of the palms of the hands and the soles of the feet, the hands and feet looking as if they had been stained with red ink. At the same time the hands and feet sweat very profusely. I may mention that exactly the same signs have already been described as belonging to alcoholic paralysis, that is to say, the redness of the hands and feet, and in some cases the thickening of the soles of the feet has been described as occurring in the so-called alcoholic paralysis. But pigmentation of the skin has never been described, as far as I can find, in connection with alcoholic paralysis so-called, nor have there been any of the other acute eruptions.

clinical characters,

paralysis,

affections of the skin,

342. Is the pigmentation a sure sign of arsenic?—No, the pigmentation is a sign that occurs in many conditions. It occurs, for instance, in tramps who have been very much troubled with body vermin, lice on the body. It occurs also in a disease known as Addison's disease, which is very similar to, but not quite the same as, arsenical poisoning, because in Addison's disease you get also pigmentation inside the mouth, which as far as I have seen does not occur in arsenical poisoning. Therefore the pigmentation does

pigmentation.

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not tell one very much; it only helps. Comparing the symptoms of so-called alcoholic paralysis with those of chronic arsenical poisoning, one would say that the sensory and motor symptoms are practically the same, but the skin symptoms are only found in the arsenical cases, and not in the so-called alcoholic paralysis cases. To show that this is so, I may say that this epidemic in Manchester had been going on for four months, and many physicians there, gentlemen who were thoroughly well acquainted with the appearances of alcoholic paralysis, who had been observing these cases for all that time, had no suspicion from the sensory and motor symptoms that they were anything but alcoholic paralysis. That shows how close the resemblance was. It was not a question of merely one observer, but of many observers who were well acquainted with alcoholic paralysis.

Alcoholic neuritis in its relations to arsenic.

343. There are other forms of neuritis, lead, diphtheria, and so on; what have you to say about them?—In the other forms of neuritis you always get something which is quite characteristic. Between the alcoholic and the arsenical neuritis, putting aside the skin symptoms, the appearances are practically the same, although they are two such very different poisons. In lead you get quite other forms, the muscles picked out are quite different. There are no sensory phenomena. In diphtheria, again, the muscles picked out in neuritis are quite different from the others. But in arsenic or alcohol the symptoms are practically the same, and this is a curious point.

344. Have you any reasons for doubting whether ordinary alcohol is, or is not the cause of the so-called alcoholic paralysis?—That is a very difficult question, and I only wish to put my views forward with great diffidence, but there are several points that make me think that alcohol *per se*, ethylic alcohol, perhaps I should say, is not the cause of neuritis. The reasons are as follows:—It was stated for many years—and it is quite an old affection which has been described many years ago—that alcoholic neuritis only occurred in spirit drinkers. The first case of alcoholic neuritis I ever saw was in 1885, sixteen years ago, and that occurred in a gentleman who drank absolutely nothing but beer. He was in an institution where I was medical officer at the time, and we knew exactly what he took. He took nothing but beer, and he developed very marked alcoholic neuritis. This case was reported by Dr. Dreschfeld some years ago, and at that time Dr. Dreschfeld said he was perfectly certain the patient also took spirits, because otherwise he would not have had neuritis. I am only telling you this to point out how certain people felt that it was caused by spirit drinking. This first case was a pure beer drinker. Since then I have seen many hundreds of alcoholic neuritis cases in hospital work, and they have invariably taken beer either alone or with spirits. I have seen many cases in private and in hospital work where people have taken nothing but spirits, and personally I have never seen a pure spirit drinker with alcoholic neuritis. I have been called in to see ladies and gentlemen who have taken, say a bottle of whisky a day, but they never had neuritis. Only within the last two or three months I have seen two such cases in consultation. One was a lady who took a bottle and a half of whisky a day, and another a bottle a day, and neither had the slightest trace of neuritis. Therefore, it seemed curious, if it were alcohol, that no trace of neuritis should be found. At various times I made enquiries from Scotch physicians, and I have been astonished to find there was so little neuritis in Edinburgh, or Glasgow. Some weeks ago now I sent to Aberdeen, Glasgow, Edinburgh, Dundee and Belfast, to ask if it were a common affection, and from five answers I received I found that my opinion that it was not alcoholic *per se* was corroborated. Last week I received an unsolicited letter. I had not written to Sir William Gairdner, but I received from him a letter on this subject, which I have his permission to use. It is published now so that if I may be allowed I should like to put that letter in. It is as follows:—"Edinburgh, February 7th, 1901. Dear sir,—I have had no desire to join in the confusion which Mr. Malcolm Morris remarks upon in the 'Practitioner' as the 'Beer scare,' but it may possibly be interesting to you to know the following, which I communicated to Sir Lauder Brunton some time ago, and at a later date to Lord Kelvin. At a date which could be approximately fixed from the fact of my being engaged at the time as an examiner for Victoria University, I had read the late Dr. Ross's account of alcoholic paralysis; but had (or supposed I had) almost no personal experience of the disease. Meeting Dr. Ross accidentally when in the midst of the clinical examinations at the Royal Infirmary, I asked him to show me some cases and, to my great surprise, he took me at once to (I think) half a dozen or more, which he at that very time had in his wards. His demonstration of the disease was most convincing; but after fully acknowledging this I said to him, 'But if this is alcoholic paralysis, how does it come about that I did not know it well before, and seem scarcely to have seen it in Glasgow, where they drink so much whisky?' This thought remained with me and kept me on the watch—as a teacher of medicine—and the few cases I afterwards saw, either in hospital or in private practice, only convinced me the more of the rare and exceptional character of the disease in Scotland, and that alcohol (though certainly associated with the disease) was not the leading factor in the etiology. I give you every credit for the remarkably interesting investigation by which you reached the truth; but no such investigation was possible for me, as the cases were so few and far between. Such as they were, however, they were always so typical that I had no difficulty about the diagnosis, and was thus the more convinced that I could not have overlooked the type, had it occurred to me in any considerable number of cases, prior to my encountering Dr. Ross, for whom, then and afterwards, I always entertained a most sincere respect, and have accordingly read, I think, everything that he wrote upon the subject.—Yours most truly, W. T. Gairdner." That letter from Sir William Gairdner showed me that I have not been mistaken in doubting whether alcohol *per se* would cause peripheral neuritis. What it is that is associated with the alcohol I cannot say. But I should like here to point out that there cannot in my mind be any doubt that neuritis has been caused by spirit drinking *per se*. For this reason: the accounts given in 1789, for instance, that given by Dr. Lettsom in 1789, are perfectly clear. The account he gave there of symptons occurring in women drinking brandy is a perfectly typical account of what we called alcoholic neuritis. Then again, Sir Samuel Wilks, about 1880, described perfectly typical cases of alcoholic neuritis occurring in spirit drinkers. So that, although I have said that I have not seen it in a pure spirit drinker, yet I cannot doubt that it has occurred in spirit drinkers; but certainly in the Manchester districts it is infinitely more common in beer drinkers or in people who have their drinks mixed, spirits and beer. From Sir William Gairdner's letter it would seem that it is certainly not common amongst pure whisky drinkers.

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Alcoholic neuritis in spirit drinkers.

345. (*Chairman.*) Have you found it in the case of beer drinkers in excess?—Previously to this epidemic only in beer drinkers in excess.

345.* Was there any suspicion of any mineral poison being connected with the illness until the present epidemic?—Until the present epidemic one did not certainly connect it with any mineral poison, but about June last year I saw in the same week several cases of the redness of the hands and feet, which I have described, known as erythro-melalgia, the older term being acrodynia—simply a painful extremity. Those cases were always supposed not to be very common, but in one week in the out-patient department I saw several cases.

346. (*Sir William Hart-Dyke.*) About what date was that?—July, 1900. I think it was the first week in July, because I gave a clinical lecture on the cases I had seen. When I returned from my holidays, about the beginning of September, in going round the wards at Crumpsall, where there are about 800 beds with medical cases in them I noticed a considerable number of cases of alcoholic paralysis. The residents had also remarked it, and we then found in one pair of wards, containing 62 beds, 25 cases of this paralysis. They began to increase in the most alarming way. I ought to say that we also noticed both in the infirmary and at the workhouse during these two or three months a considerable number of patients with most peculiar eruptions, some looked like measles and some like scarlet fever. We also noticed a considerable increase in the number of cases of shingles.

347. (*Sir William Church.*) This would be in May, June and July, you are speaking of?—Yes; then on the 15th November, in chatting with one of the assistants at Crumpsall, over the various skin rashes we had seen in those cases, Dr. Sissons, the resident there, mentioned to me that I had forgotten to mention herpes; and then it suddenly flashed across my mind, "Why, there must be arsenic in the beer the people are drink-

ing." We had already shown pretty clearly that all the patients who were suffering were beer drinkers. This seemed very unreasonable, but my reason for suggesting it was that if it were any known drug in the beer, then it was probably arsenic, because of all known drugs arsenic is the only drug which causes shingles. It then, of course, became a simple matter. I obtained some of the beer on the 17th November, and on the 18th November I tested it by Reinsch's method and got a considerable ring of cystals of arsenious oxide in my reduction tube. On the 19th November I communicated this to Dr. Dixon Mann, who was far more skilled in this work than I was, and on the 20th he obtained from a separate sample of beer—I believe it came from the same brewery—crystals of arsenious oxide.

348. (*Chairman.*) That was the first knowledge of the present epidemic?—Yes.

349. Had you heard that beer drinkers had become alarmed by feeling themselves ill a month or two months before that time?—I only heard that afterwards.

350. Did the symptoms in the present epidemic agree with the symptoms you have been already describing, or were some new class developed?—They agreed exactly with the symptoms I have been describing as occurring in arsenical cases. They also agreed absolutely with the epidemic which was called acrodynia, which occurred in Paris in 1828, and described by Genest in the "Archives Générale de Médecin" for 1828 and 1829. The same epidemic is also described in a thesis by Rochette, published in 1871, in which the whole of the symptoms are very carefully given. In the 1828 epidemic nobody imagined that it was arsenical.

351. In the earlier case was it imagined to be arsenical?—No, nobody imagined it was arsenical. Nobody ever knew what that epidemic was. It was very extensive, but nobody imagined what it was until another epidemic occurred in Hyères in 1839. That was undoubtedly arsenical, and was due to arsenic having been put into wine instead of plaster. Plaster, I believe, gypsum, is put into wine for some purpose or another, and instead of the gypsum arsenic had been put in, and that caused an epidemic in Hyères, with about 400 cases.

352. Were there any deaths?—I do not know how many deaths there were.

353. Did this last a considerable time?—Yes, for some time.

354. Was it early discovered to be due to something in the wine?—Yes; in that case the pigmentation gave the key to the difficulty in the Hyères epidemic.

355. And this was just one lot of wine?—Yes.

356. Was it called acrodynia?—Not in the Hyères epidemic. The other epidemic in 1828 was simply described as acrodynia. A commission was appointed, and I have read its report, but it came to the conclusion that it did not know what it was.

357. In the light of subsequent knowledge, does there seem any probability that arsenic may have been the cause?—The symptoms are so well described in that epidemic that I felt I must have copied from the Report in my paper which I wrote on this epidemic a short time ago. The two papers are most ludicrously similar. Expressions are used in the same way, and I had not seen the paper on the previous epidemic before I had written my own. The descriptions tally exactly.

358. There was a second case in France, I believe?—Yes, another at Havre. That is a very interesting case, because there it was homicidal. There were 15 people affected, and three died. It was investigated by Brouardel in 1889, and is reported in the *Annales de Hygiène* for 1889.

359. It was homicide by poison?—Yes, by arsenic.

360. Was it known to be arsenic?—Yes. Brouardel found that out, and it was clearly shown to be arsenical poison. In those cases again, the symptoms were exactly similar to the symptoms in the present epidemic.

361. That makes it probable that the case in Paris in 1828 may have been arsenic?—I do not think there can be the slightest doubt about it.

362. Looking back on it now, is there any suggestion as to how it could have been arsenic?—I think it was probably accidental.

363. I think you have described the chronological order of the symptoms?—The chronological order can be put very shortly in the present epidemic. The digestive symptoms have started first. In many cases we found these digestive symptoms, and I should say that perhaps 50 per cent. of the cases had either vomiting or diarrhœa while they have been drinking this particular beer. Sometimes the symptoms have been those of cold in the head, and the irritation of the larynx, and the less irritation of the bronchii, giving rise to laryngitis, and to bronchitis. About this time the acute skin lesions have appeared, the acute rashes. Within a few days, sometimes almost at the same time, we have had the sensory disturbances, burning of the hands and feet; and then in about three or four more days the patients have complained of the loss of power, especially in the feet, and partly in the hands. About 75 per cent. of the cases have complained of some loss of power, and in some cases the loss of power was so great that they could not move at all. They were lying perfectly helpless, paralysed, in bed. About this time, or after, one noticed the darkening of the skin, and later on the thickening of the soles of the feet and the palms of the hand.

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Symptoms of the epidemic cases.

364. What would be the earliest time in 1900 when the severe symptoms you have just described were observed?—The cases of erythro-melalgia, or painful hands and feet, which I first saw were at the end of June.

365. And did they develop with full severity such as you have described?—They developed pretty quickly.

366. Were they in full severity in June?—Yes, but they were only cases showing the redness of the hands and feet. They were early symptoms undoubtedly, and many of them got worse afterwards.

367. In July or August?—In August I was away for my holidays, but when I came back in September, I found this great increase in the numbers of so-called alcoholic paralysis at the workhouse.

368. So that in September the epidemic seems to have been fully developed?—Yes; but our maximum of cases occurred in November. This table illustrates the point.

Statistics of cases in Crumpsall Infirmary.

ESTIMATE of Cases suffering from marked Alcoholic or Arsenical Symptoms admitted to Manchester Workhouse Infirmary in 1900.

——	Males.	Females.	Total.
January	4	6	10
February	5	2	7
March	3	4	7
April	7	3	10
May	16	3	19
June	21	11	32
July	25	7	32
August	15	11	26
September	32	18	50
October	40	39	79
November	55	53	108
December	40	24	64
	263	181	444

369. Have you any remarks to make with respect to classification of cases?—This has been a little difficult, and it is largely due to the peculiar idiosyncrasy which people seem to have as regards arsenic. For instance, in some cases the wife has been so bad that she has died, and there has been a coroner's inquest, and the husband, who said he took quite as much beer of the same kind, or perhaps more, than his wife, was hardly suffering at all. Those occurred in one or two instances.

Individual susceptibility to arsenic.

370. Then there were coroner's inquests before the epidemic became generally known?—No; I mean coroner's inquests since. I am only giving that as an instance, to show how some people were affected, and others not affected at all. Therefore, it is a little difficult to classify the cases; but one might classify them somewhat in this way: One group presented practically all the symptoms, another group only presented symptoms of heart or liver affection; that is to say, they were breathless, and had swollen feet, and perhaps a very few sensory disturbances. Other cases, again, had principally sensory disturbances, and nothing much else, and other cases had sensory and motor disturbances. It was these latter cases, the sensory and motor cases, presenting practically no other symptoms, which looked exactly like the old cases of alcoholic paralysis; but even in these cases a careful examination of the soles of the feet not infrequently revealed scales, so that it seems to me very probable that many of the cases which we have been calling alcoholic-paralysis for some years now, if we

Different types of disease met with during the epidemic.

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had only known of the small symptoms to look for—the scales on the soles of the feet, the slight duskiness of the skin, and so on—we should have not only looked for them, but found them and called it by something else. We simply did not know of their probability. Since then we have always looked for them, and in most of the cases we have found them. In this classification I should just like to throw out another suggestion, which is merely a suggestion. It seems to me possible that quite small quantities of arsenic—not the comparatively large quantities which have been present in this epidemic, but quite small quantities—taken for considerable periods, may, by accumulating in the system, as this epidemic has shown they will accumulate, set up paralysis without any of the other symptoms. We know that lead in quite minute doses, taken for long periods, will gradually set up a neuritis, and the resemblance of the alcoholic neuritis and arsenical neuritis is so extraordinarily great that it seems to me quite possible very large numbers of these cases for some years have really been due to quite minute traces of arsenic in alcoholic liquors. That, of course, is merely a suggestion, which I cannot prove in any way.

Cumulative effect of arsenic.

Individual susceptibility to arsenic.

371. How small do you think these very minute traces may be?—I should not like to attempt to give any size of dose, considering how peculiarly susceptible some people are to arsenic. For instance, in some cases 1-25th of a grain taken three times a day for two or three days will cause symptoms of arsenical poisoning, acute symptoms. The 1-25th of a grain of arsenious acid taken three times a day for a few days has been known to cause fairly acute symptoms of arsenical poisoning.

372. Amounting to about $\frac{1}{8}$ of a grain a day?—Yes, but that is only in a person very susceptible to it.

373. That would be taken in three days; but suppose the same quantity was taken in a large quantity of liquor, would not the greater part of it pass through without producing any disturbances at all?—It has been always supposed that it would, and it has been supposed that arsenic was very quickly eliminated by the urine; but this epidemic in reality has only revived what was known before, in France, at any rate, that arsenic is stored up in very large quantities in the body. It is stored up in the skin, in the hair, in the nails, and in the bones. Therefore, instead of its being rapidly eliminated, as many books have stated, it is nothing of the kind—it is stored up in the body, and seems to be selected in a peculiar way by certain organs of the body.

Affinity of arsenic to certain tissues.

374. Taken in a solution, such as Fowler's solution for instance, will the tissues take the arsenic out and send the liquid away?—Yes, there is no doubt about that at all.

375. We do not know, except from this epidemic, the results of small quantities of arsenic in alcoholic drinks. Are we to suppose that the arsenic in the beer was dissolved?—That I cannot speak about, not being a chemist, but I should imagine it was dissolved in the beer. You see it would have to pass from the stomach through the liver before it could get to the kidneys, and it is in the liver apparently where it gets first seized upon.

376. And in the body it may be taken out from solution?—Apparently a considerable amount of it may be taken out of solution. At any rate, it does certainly get stored up, because even in this epidemic it has been found in the scales of the skin. The scales that have come off the hands and feet have been examined. I suppose you will get the evidence from others. I have not examined them, but arsenic has been found in these scales, and it has also been found in the hair and in the clippings from the nails of these patients.

377. In considerable quantities?—In weighable quantities.

378. And in post mortem examinations has there been much found in the tissues?—There is nothing very much in the appearance at the post mortem which would show there has been arsenic unless the tissues are examined carefully. The liver has been enlarged and fatty and in a state of chronic inflammation in some cases. In other cases the heart has been fatty and very dilated. In fact, most of the patients have died from heart failure just as they did in the Havre epidemic. The three cases there died from heart failure. But beyond that there has not been very much change that you could lay hold of; certainly in the naked eye appearance you could not have possibly said it was arsenical poisoning

Cardiac failure.

You could only tell it by chemical analysis of the tissues.

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379. Could you tell us the number of cases personally dealt with at the Crumpsall Workhouse and at the Manchester Royal Infirmary?—The number of cases I have seen since the beginning of 1900 in the Crumpsall Workhouse at Manchester has been: Males, 263; females, 171; or a total of 434. At the Manchester Royal Infirmary in the out-patient department in November and December—I have not counted them since—there there were: males, 110; females, 60; total, 170. Since then I have seen at the infirmary a considerable number of others. I expect I have seen about 650 cases personally.

Crumpsall statistics.

380. What were the number of fatal cases?—15; 12 women and three men.

381. So that the fatal cases were more numerous amongst the women than the men?—Yes. And that brings us back to another point. Severe symptoms were much worse in women, and I think for this reason in the early part of the epidemic not only myself but others thought that the disease was more common in women. Possibly it might be if you take the percentage of those who drink beer amongst women and amongst men. That, of course, is a very difficult thing to get out. But of the actual number of cases coming to a hospital it has been more common in men. Again, there is another little fallacy here. Some of the women, especially after it was known what these symptoms were due to, became very shy, and unless they were suffering very severely would not come to the hospital, because they knew that these symptoms meant that they had been drinking beer. After it was known what the symptoms were due to they stopped coming to a large extent unless they were really very bad; but the severity of the symptoms were much worse in women, and the deaths, as I have said, were six times as common as in men.

382. Which were six times as common?—The deaths were about six times as common in women as in men, taking the percentages. Exactly the same thing was noticed in alcoholic neuritis years ago, that it was much more common, or the symptoms were much more marked in women than in men.

Women more severely affected than men.

383. (*Dr. Whitelegge.*) Do you mean that the cases were more numerous or more severe in women?—They were said to be more numerous, and I think they were.

384. And were they also more severe?—Certainly. We got more actual paralysis and helplessness in the women than in the men.

385. (*Chairman.*) Do you attribute that to the women having drank more than the men or being more susceptible?—To being more susceptible. As regards the women, I am quite sure, from a very searching examination of some of these people—and I have examined some hundreds of them—some of them had not taken more than what they called three half-pints a day; that is to say, a pint and a half of beer per day. Many of the women did not take more than a pint and a half of beer a day.

386. That would not be at all more than would be good for their health if the beer had been pure?—I think not.

387. Is Crumpsall Hospital a workhouse infirmary?—Yes.

388. Did the patients get beer in the workhouse?—No, the patients did not get any beer in the workhouse.

389. Does the workhouse hospital take patients other than from the workhouse?—Yes, from the whole of the township of Manchester, which is the central part of Manchester.

390. Why it is called the workhouse infirmary?—Because it is under the Poor Law.

391. I misunderstood you; I thought it was the hospital of the workhouse?—It is the workhouse infirmary. There is a workhouse close by.

392. But it is not confined to patients from the workhouse?—No, it is open to any poor people.

393. Have you any further information or opinions to give regarding previous epidemics of arsenical poisoning?—Only those I have already mentioned.

394. Have you any further information you would wish to give us?—I do not think so.

395. (*Sir William Church.*) You say rightly enough that the profession has been long acquainted with what was called alcoholic paralysis, but could you tell me how long it had been made use of in Manchester by the

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Registrar of Deaths?—I should say since about 1885. I fix that date for the reason that at that time I was at Cheadle Asylum as a resident medical officer.

396. It certainly would not be before that, because it was not in the nomenclature of diseases till then?—Very possibly. I did not know that, but exactly at that time an extremely good physician in Manchester saw a case with me, and had not the slightest idea of what it was. Dr. Dreschfeld saw it soon after, and agreed with me that it was alcoholic paralysis. I happened to know it because of Sir Samuel Wilks' account of the disease. All that proves that up to that time it was not described in the certificates.

397. How long have you been in practice or attached to the hospital at Manchester?—I have been in practice since 1883—18 years.

ralence of holic itis in chester.

398. Apart from last year, do you think that cases had been increasing in frequency?—No, certainly not at the Manchester Infirmary, and from my general feeling not at Crumpsall. We have no figures for Crumpsall, unfortunately, but at the Manchester Infirmary certainly not.

399. Did you study medicine in London as a student?—No, in Manchester.

400. Have you any London experience?—No.

401. Because in the figures that you gave in, I think you said there were annually 1,500 medical patients in the Royal Infirmary at Manchester in the wards, and 20 cases of so-called alcoholic neuritis?—Yes.

402. That far exceeds what I think would be the figures in any of our Metropolitan hospitals?—That is to say, you think it is also more common in Manchester?

403. Much?—That is my feeling.

404. I have had 40 years' experience at Bartholomew's, and in a much larger number of patients than 1,500 medical patients in the wards we did not get three or four or five?—My statement about London was made on the strength of many conversations I have had with London physicians whom I have met from time to time in Manchester. I had no personal experience; it was simply a general feeling that I felt it was commoner in Manchester than in London.

405. You went on so far as to question whether there was alcoholic paralysis? Have you any doubt in your own mind whether there is alcoholic paralysis or not?—I cannot help but doubt, considering Sir William Gairdner's letter, as regards Scotland. The amount of alcohol *per se* that they take in Scotland is very great, and if with all his enormous experience he has seen so few cases, I cannot help but doubt that it is not due to alcohol *per se*. Of course I cannot say it is not due to some other impurity. I do not mean to say it has been always arsenic by any means.

406. That is what I wanted to elicit?—I should not like to go as far as that, but it certainly looks very suggestive.

407. But that there has been for long a form of peripheral neuritis and paralysis associated with the consumption of alcohol you have no doubt?—Not the slightest.

nical ning in chester e 1900.

408. I should rather like to know whether it is your impression that probably the cases you saw previous to 1900 were arsenical?—I can only suggest that they were, simply from the extremely close resemblance of the symptoms and from the very fact which I mentioned that such good observers as there are in Manchester, Dr. Dreschfeld, Dr. Bury, and so, who were actually seeing these cases, never noticed anything different for a good three months. Dr. Dreschfeld noticed that some of them were peculiarly dark, but even that did not draw his attention to the fact that there was any difference in the paralysis, which shows that there was no difference. The cases went on, and everybody thought, as a matter of fact, that it had something to do with the increase in drinking. They assumed that people were drinking more because of the war, for some reason or another. But the character of the paralysis did not suggest to them that there was anything different.

409. But the cases previous to last year did not have the skin affections, did they?—Yes, some of them did. The other day I looked up the late Dr. Ross's account. He was writing this account at the time I was resident medical officer at the Manchester Royal Infirmary, and in this account it is most curious how he describes many of the patients with the redness of the hands and feet and the profuse sweating of the hands and feet, and in some cases he mentioned the thickness of the soles of the feet, so that there had been skin eruptions in some of these so-called alcoholic cases.

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410. (*Dr. Whitelegge.*) And pigmentation?—No; I do not know.

411. That is new?—That is new. I should like to put the pigmentation rather before May. I think even at the beginning of last year my assistants at Crumpsall on one or two occasions asked me to go to a particular case because they thought they had a case of what is called Addison's Disease. I was asked to see the cases. In none of the case of so-called Addison's Disease was I able to satisfy myself that it was Addison's Disease. I said I did not know what it was, but it was not Addison's Disease. That was before May. I am inclined to think it was February or January. They were all heavy drinkers. Pigmentation.

412. (*Chairman.*) January or February, 1900?—I think so.

413. (*Sir William Church.*) But you are clear in your own mind that, although there were some skin affections, those we have been accustomed to in alcoholic paralysis, at all events there was no pigmentation before 1900?—Yes.

414. You said that a very small amount taken continuously, you thought, might produce peripheral neuritis. What is your ground for thinking that, other than what you have seen lately?—That, as I said, was merely a suggestion. My ground for thinking it is this, that arsenic seems to have such a peculiar susceptibility to seize certain tissues, particularly tissues containing keratin, and after the suggestion made by Dr. Dixon Mann the other day, pointing out how much keratin there was in the nerve tissues, it struck me: Was it not possible also that arsenic, which when taken in comparatively small doses can be found in the hair, in the scales of the skin, and in the nails, might be also found to cause neuritis? Quite minute doses of lead taken for long periods, without causing any of the acute symptoms of lead poisoning, will cause paralysis, and I asked myself whether it was not possible for arsenic to do the same thing. Arsenic and keratin.

415. Have you ever known any symptoms like these to arise, in the course of your practice, in skin diseases where arsenic is given for a very long period?—I have seen pigmentation on one or two occasions. I have seen two cases, one a woman who had slight pigmentation and slight paralysis of the hands—I think it was a case of Dr. Ross's; and the other was the most marked case I have ever seen, a girl I saw in consultation, who had had a plaster applied to a tumour on her back, in Ireland. She was brought to England paralysed, and I was asked to see her, because it was supposed that this tumour had affected her spinal cord. She had pigmentation and typical arsenical paralysis, and that was merely from the application of an arsenical plaster to the outside skin.

416. (*Sir William Church.*) What was the date of that case?—Probably about 1896.

417. (*Chairman.*) Did she get well?—Yes.

418. (*Dr. Whitelegge.*) So that you recognised at that time that motor and sensory paralysis depended on arsenic?—Yes; the diagnosis was quite easy.

419. (*Chairman.*) Is it possible that the cases which surprised Sir William Gairdner may have been the result of arsenicated beer?—It is quite possible, but if so, it must have been in very minute doses, because otherwise they would have had some more marked skin symptoms than they had.

420. (*Sir William Church.*) You said that about 50 per cent. only had initial symptoms pointing to the digestive system?—I think it was about 50 per cent. Gastro-intestinal symptoms in the epidemic.

421. Vomiting and diarrhœa?—Either vomiting or diarrhœa, or both.

422. Did those cases become the worst ones?—I think perhaps, on the whole, they did. I never thought of it in that light before, but perhaps they did.

423. Ordinarily, when an overdose has been given medicinally or accidentally, those are the commonest symptoms of arsenical poison?—Exactly.

424. You could not say whether those that had vomited or had diarrhœa, or both, turned out to be generally the most severe cases,—I think, on the whole, I can say they did—that they turned out the severer cases. And yet not always, for this reason, that some of them who vomited and had diarrhœa had the good sense to at once change their liquor. That was given

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to me as a reason on several occasions. They said the beer was not agreeing with them, and they had been taking spirits. Some of them came to the out-patients' room of the infirmary, and I told them at once when I saw their faces that they had been drinking beer. Some denied it so emphatically that they made me think I had made a mistake, but on sticking to them and pressing them to tell me everything they admitted it. They at first said they were spirit drinkers, and when I asked them how long they had been drinking spirits, they said they had been drinking them for about a fortnight, and drank beer before. Then I have asked them why they have stopped taking beer, and they said because it did not agree with them. That history was given me in one or two cases.

425. In your experience there had been more men affected, although not so severely affected, than women?—I have seen more men.

Incidence on sex.

426. Dr. Tattersall's experience was rather the reverse; there was not a very great difference between the numbers affected; but like yourself, there were many more deaths in women. Have you any explanation to offer as to that?—The point is this. The men came with quite slight symptoms. If they had simply tinglings in the hands and feet they came at once to the out-patient room. Those would not be the sort of cases Dr. Tattersall would see. He would have seen quite the worst cases—patients lying at home paralysed. But I saw men who were suffering from quite slight symptoms, and certainly they came in larger numbers than the women. Proportionately to the number of women drinking as compared with the number of men drinking, speaking without any proof, I should be inclined to think that the percentage of women affected was greater than the men. The actual percentage of drinking women as compared with drinking men is not quite so great. You see the difference in the figures.

427-8. 253 and 171?—Yes. I do not know what the normal rate of beer drinking amongst men and women is, but if we knew that one could get a percentage. I am inclined to think that the percentage rate amongst beer drinkers has been greater among women, although the actual numbers have been greater amongst men.

429. You have no evidence that arsenic, when given intentionally, affects one sex more than the other, have you?—No; except, curiously enough, the only three cases I have seen have been in women. I saw a case last week of a nurse who had the symptoms. She was a nurse at Crumpsall, and much to the amusement of her fellow-nurses she had these symptoms, but to a very slight degree. I went to see her last week, and asked her if she had not been taking some medicine on her own account, and she said she had. She told me she had been taking medicine that some patient was taking in one of the wards as a tonic. I sent for the medicine, and found it contained 1-20th of a grain of arsenious oxide in a dose, 5 minims of liquor arsenicalis. She had taken that for a fortnight.

430. I ask you as a result of your former experience, had it ever crossed your mind that one sex was more liable to suffer from medicinal doses than another?—No; I don't think it has.

431. In the fatal cases you say they usually died from heart failure?—Yes, generally.

432. What was the condition of the heart?—In some cases the heart muscle was fatty and the heart cavities dilated.

433. You mean that it was fatty degeneration?—Yes.

Toxic effect of arsenic increased by alcohol.

434. (*Dr. Whitelegge.*) Do you think that alcohol is a predisposing cause to arsenical mischief?—Yes, I think so, because the medicinal dose that one generally gives without alcohol certainly has not seemed to produce these symptoms, although they have been apparently as large as those in beer. Therefore I am inclined to think that the alcohol in some way helps the arsenical symptoms to develop.

435. They may be parallel forces acting together?—Yes.

436. Is alcoholism regarded at all as contra-indicating arsenic?—I never looked upon it as such before.

437. Have you found from the history of the patients whom you have seen in this epidemic that they were generally in a weak state of health before the arsenical mischief began?—No; many of them were quite robust individuals.

438. The suggestion has been made that pigmentation in these cases was associated more with moderate drinking than with heavy drinking?—I should not think so.

439. You have spoken of the cumulative effects of arsenic. You would not think that deposit in the epidermis, the hair, and the nails, was a storing up in the same sense as the storing up in the case of lead, would you? It would hardly come back again into the circulation in those cases—so to speak, it is practically eliminated?—Yes; it would not come back again.

Dr. E. Reynol

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Eliminat of arseni

440. The storing up you meant was a deposit in some tissue inside the body?—Yes.

441. Do you know of any experiments on animals throwing light upon this question?—No.

442. In the figures you gave us for Crumpsall and the out-patient department of the Royal Infirmary, were there equal facilities for each sex? Was there, for example, in the case of Crumpsall a larger provision for male patients than female patients, or *vice versâ*. Was the way open for all those of either sex who would naturally present themselves to come into the Crumpsall wards?—Yes.

Crumps statistic

443. There was no exclusion?—None whatever. There were plenty of beds on both sides.

444. Has any attempt been made at Crumpsall or elsewhere to obtain figures as to the consumption of beer by people of the same class, apart from the neuritis cases?—I don't think so. Do you mean the normal consumption of beer?

445. Yes, a control experiment as it were?—No, I do not think so. Many of these people spoke quite freely to me about it, and told me what their general beer drinking habits were.

446. You are referring to the patients?—Yes.

447. I meant those who were not patients—there is no standard or datum to go upon?—No, I have certainly not got any other figures.

448. Is there anything else you could suggest that would amount to predisposition to arsenical poison? Do you attach any importance, for example, to the suggestion of influenza or other influences of that kind?—Certainly not to influenza. In fact, during the last four months we have had less influenza at Crumpsall than we have had for the last ten years at the same time of the year. In fact, we have hardly had any. During the last ten years we have always at this time of the year had many cases.

Epiden not related influen

449. That would rather point to improbability of arsenical poisoning predisposing to influenza. There was no special prevalence of influenza before the epidemic began?—No.

450. Nor was there any special incidence of neuritis upon those who had suffered from influenza?—No.

451. I am not sure whether you have given us any figures showing the duration of the fatal cases?—I am afraid I have not got them, but I could get them if you wish for them.

452. Would all the patients in Crumpsall be of the poorer class?—Yes, quite the poorest class.

Class perso attack

453. Have you any knowledge of a comparable kind with regard to peripheral neuritis in the upper classes?—Only from my own private work, and I have no family practice, so that it is a little difficult for me to say anything of that.

454. Probably you would hear about it from practitioners?—Yes, but there has not been much, or comparatively little.

455. The main incidence has been on the poorer classes?—Yes. I have seen one or two cases amongst the middle class, but certainly it is principally amongst the poorer classes.

Paris epide

456. You referred to some cases in Paris in 1828. Was there any suggestion there that there might have been arsenic?—Certainly not.

457. Were there any circumstances pointing to arsenic?—Not the slightest, but the description exactly tallies with the description of arsenical poisoning as seen in the recent epidemic.

458. But where there are cases of alcoholic paralysis you would now be inclined to suspect arsenic?—I should be inclined to suspect it, but I should not feel inclined to go any further.

Ment symp

459. (*Sir William Church.*) With regard to the mental condition, was there any difference in the mental condition of the patients during the last few months and those which you were accustomed to see in previous years?—Not the slightest. It was exactly the same kind.

SECOND DAY.

AT WESTMINSTER PALACE HOTEL.

Friday, 1st March, 1901.

PRESENT:

The Right Hon. LORD KELVIN (in the Chair).

The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Professor THORPE.
Mr. COSMO BONSOR.
Dr. WHITELEGGE.

Dr BUCHANAN, *Secretary.*

Mr. JAMES NIVEN, called; and Examined.

J. Niven.

Mr. J. Niven. 1 March 1901.

460. (*Chairman.*) I believe you are the Medical Officer of Health for the City of Manchester, and you have lately presented a report to the town council on arsenical poisoning in the city?—That is so.

461. And you give evidence with regard to the recent exceptional sickness in the City of Manchester attributable to poisoning by arsenic?—Yes. The evidence which I have to give on this subject is derived partly from observation of cases in the union infirmaries and elsewhere, but mainly from a circular which was sent out to all the medical men of the city on the 27th of November.

462. This is a copy of the circular you sent out?—Yes.

463. And from the answers to this circular you derived a considerable amount of information?—That is so. The number of circulars sent out to medical men was 358, and the replies reporting cases were 124. The replies from medical men who had no cases were 49; that is to say, that somewhat over one-half of the whole of the medical men of the city did not send any reply to the circular—185 sent no reply. I know, from personal knowledge, that one or two men had a number of cases, and I infer from the districts in which they lived that, at any rate, a fair number would also have cases of this poisoning.

464. Have you any reason to suggest why they did not reply?—Pressure of work, simply. Many medical men have such an immense amount of work that they are run off their feet, and quite tired out in the evening, and I presume they did not feel equal to sitting down and replying accurately to a document of this description. I can quite understand it.

465. May it have been in private practice that some of the medical practitioners did not wish to reply?—I do not know that one would like to draw inferences of that description. I have in my mind one gentleman in particular who I know would not be deterred by that reason, and he did not send an answer. It is possible, of course, but I should not like to say that that was the principal reason for not answering the circular. I have made a summary of the number of cases which were reported in that way by the medical men of the city, and I find that those reporting cases without any qualification whatever reported 1,534 cases.

466. Without qualification?—That is to say without stating either that the cases were the severest cases or that they were not the severest cases. Those who qualified their cases, nearly all of them in the direction that they were only giving the severest cases, reported 240. The number reported by Union District officers was 254, and the number of medical men who reported large numbers of cases was nine.

467. (*Dr. Whitelegge.*) Reported that they had large numbers?—Yes, that they had large numbers of cases.

468. Without giving details?—Yes, without giving the details. I have put that down in round numbers as, say, 250.

469. (*Chairman.*) Were those who had large numbers to report in any special line of medical practice?—No, not all of them. One of them was a Union District officer. Those of them who reported in that way were people who had large practices amongst the poorest classes, or who were officers of public institutions. One or two were medical men having large practices among the poorer people. The numbers reported as in the union infirmaries, Crumpsall, since October—I take the latest number given by Dr. Reynolds to this Commission—was about 400. The Chorlton Union Infirmary estimate was 200, of whom there might be 150 Manchester patients. The total is 2,828. From these I propose to subtract 552, made up in this manner: 100 patients at public institutions, such as the infirmary, coming from outside Manchester, the whole of the 254 reported by Union District officers, as it is just possible that all of them might afterwards have been taken into the Poor Law union infirmaries. We found there were 550 in the Poor Law infirmaries, and subtracting 254 we get 296 cases remaining. I propose to take off one-half of these as possibly included in the returns from practitioners who are not district officers, and who may subsequently have gone into the infirmaries. I propose to take off 50 cases as possible duplications at institutions. That leaves 2,276 cases reported as suffering from peripheral neuritis or arsenical poisoning. Almost all seem to be within the last six months, though not quite, because a few were reported in earlier months. One may, of course, allow for a margin of error, but if one takes into account the large number of medical men who did not report, I think it is quite safe to say that at least 2,000 cases must have occurred in the city within the last six months.

Peripheral neuritis and arsenic.

470. Have you reason to distinguish between peripheral neuritis due to arsenical poisoning and other causes?—That is a very large question indeed. There are a very large number of causes which give rise to peripheral neuritis. The reason that one looks upon all these recent cases, or the great majority of them, as having been due to arsenical poisoning is partly the short period within which the illness has begun. It has not been a gradually dawning illness, but an illness marked by a somewhat definite onset, and those cases have been all associated with the drinking of beer or stout. When I say all of them, I mean all of them with slight exceptions, say one or two cases, that may be neglected, considering how likely it is that a certain number of people will not admit that they have been taking beer or stout. Taking these things into consideration, one regards, at all events, the recent cases of peripheral neuritis as mostly due to the influence of arsenical poisoning. There has been no other cause at work which one is aware of. Other causes have formerly been at work, such as poisoning by bi-chromate of lead, to a very limited extent in one works; poisoning by bisulphide of carbon in another works. That, again, was extremely limited. During the influenza outbreak a certain number of cases of peripheral neuritis were ascribed to that disease, but on this occasion there has been no disease to which one could assign these cases of peripheral neuritis. There has been nothing which would induce one to think that they were not due to arsenical poisoning except only the continuous habit of drinking large quantities of beer or stout. That is to say, the only other case which one could think of in connection with the cases was alcoholic poisoning. The question has arisen lately how many of these cases of so-called alcoholic neuritis may have been formerly due to the effects of arsenic.

471. Previous cases?—I do not think it is necessary to go into that question, because the main element here is the enormous number of cases which have been observed within a limited period, the origin of which has been recent, and which, therefore, are, to a certain extent, unlike alcoholic neuritis, in which the progress of the case is slower. I do not say that as an absolute distinction. It is extremely difficult to make a precise and

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clear distinction between peripheral neuritis due to alcoholic poisoning and peripheral neuritis due to arsenical poisoning. Indeed, many practitioners in the earlier stages of this no doubt (I know some did, and I have no doubt many others) looked upon these cases as alcoholic cases. There have been in a number of the cases certain phenomena which have clearly marked them out as due to arsenic, or, at all events, which has marked out the patients as suffering from arsenical poisoning, the principal features of that nature being pigmentation of the skin and certain very distinctive rashes. There is also another feature which, however, has not been until recently worked out, viz., an extremely horny condition of certain parts of the skin, especially the hands and feet. It has been found by different observers that the horny cuticle is very rich in arsenic, which, of course, proves that these conditions were due to arsenical poisoning. These are the main conditions which have pointed definitely to arsenic, but these conditions have been present only in a portion of the cases and not in all of them. The wasting, profuse sweating, and other symptoms which are common to alcoholic and arsenical poisoning have been present also in these recent cases, without the pigmentation and without the arsenical rashes; so that it is largely by inference that one regards them as due to arsenical poisoning.

472. Do you consider that there is good reason for believing that in a very large proportion of this 2,000 cases the illness has been due to arsenic?—Yes. I put it at as low a figure as possible. I think one may regard that as the minimum estimate of the number that have actually suffered from symptoms of arsenical poisoning.

Peripheral neuritis in Manchester before 1900.

473-4. Is there information as to the number of deaths from peripheral neuritis and from other neuritis and from chronic alcoholism in the City of Manchester during the past five years?—Yes; I present a table showing for each week during the last ten years, that is to say, from 1891 to 1900 inclusive, the deaths registered from peripheral neuritis, other neuritis, alcoholism, cirrhosis of the liver, other liver disease, and gastritis in adults, and the total number from all these causes. (*See* Tables A and B of Appendix No. 3.) This table shows that death from peripheral neuritis and from other neuritis have been increasing in number since 1896, and that the number of deaths from chronic alcoholism and from cirrhosis of the liver has fluctuated from one year to another, but that from each of these causes of death a great increase has occurred in the year 1900.

475. (*Dr. Whitelegge.*) Would not your table rather show the increase of cases commencing earlier in 1893? I was going to come to that. The latter part of the table was only prepared in the first instance, and the first five years is supplementary. The first marked increase in peripheral neuritis is in the year 1893. In 1891 the deaths were 8; in 1892, 9; in 1893, 14; in 1894, 17; and in 1895, 17.

476. (*Chairman.*) Are those deaths from peripheral neuritis?—They are simply from peripheral neuritis. In 1896, 14; in 1897, 13; in 1898, 19; in 1899, 20; and in 1900, 48.

477. That is more than in any previous year?—A very great increase indeed upon previous years. The first increase took place in 1893. Then there is not any decided continued increase until the year 1900, when the number of deaths springs up very suddenly from 20 to 48. Without reading the figures again, the same thing is observable under "neuritis." There is a very remarkable increase from neuritis in the year 1893 from two in the previous year to ten, and again from five in 1899 to twelve in 1900. There is no doubt that the increase in the last year is due to arsenical poisoning, but it is not so easy at this point of time to account for the very marked increase in the year 1893. I have considered the various causes as well as I could which could have occasioned that increase, but I am not able to account for it.

478. (*Professor Thorpe.*) You mean in 1893?—Yes, in the year 1893.

479. (*Mr. Cosmo Bonsor.*) Were you medical officer in 1893?—I was not; but of course I have all the records. There was in 1893 no outbreak of disease which would give rise to a large amount of peripheral neuritis—no outbreak of diseases known to be causes of peripheral neuritis.

480. (*Chairman.*) Or other neuritis?—Or other neuritis. Moreover, it is true that a great deal of discussion in the medical papers had taken place with regard to alcoholic neuritis, but that discussion took place chiefly in 1889, and went back as far as 1886. It may be that medical men were getting educated, but that scarcely seems to account for it, because if that were the cause there would not be the subsequent drop.

481. (*Sir William Church.*) When did you first make use of the term "peripheral neuritis" or "neuritis" in the registration of deaths in Manchester?—I am not able to tell you that, because our records do not go back.

482. It was only introduced into the official nomenclature of diseases in 1885, and it took some time before the profession became thoroughly conversant with the new additions to the nomenclature of disease?—Yes. I say that is the cause which presents itself as a possibility. It is singular, however, that it should take such a sudden ascent in one year. It is not a gradual ascent such as you would expect from the effects of education; it is a sudden ascent, which is only barely maintained in subsequent years, or is not maintained.

483. The fact of there being, as you mentioned that there was, a good deal of discussion going on in the medical journals would perhaps have a greater effect than the mere alteration in the official nomenclature?—I think it would; but then that discussion was prior to the years 1891-2, and it is singular that it did not have more effect upon the nomenclature in those years.

Slight increase in cases in 1893.

484. (*Professor Thorpe.*) Was it a period of inflated trade, or were there any economical questions such as increased wage-earning, which might possibly account for it in 1893 or just immediately prior to 1893? Was Manchester at that time particularly well off, as far as trade went?—That I cannot tell you. From the table handed in you will see that in 1893 (it is a singular thing, and I do not want to lay too much stress upon it) the deaths seemed to be grouped together somewhat from the 26th to the 36th week. No fewer than seven out of fourteen occurred in these weeks.

485. (*Chairman.*) Fourteen weeks of the year 1893?—No; eleven weeks of the year 1893 after the cases occurred.

486. (*Professor Thorpe.*) What months would that be?—The 26th is midsummer, of course.

487. It would be from the summer to the autumn of the year?—It would be in June, July, and August, the hot months of the year.

488. A period of the year, too, when the operative class would be taking such holidays as they would get?—Yes, that would be so. But it is singular that it is not so in other years. It is very striking in that very year the way in which the deaths are grouped together.

489. (*Sir William Church.*) The total deaths in that year is the heaviest, too, from these different causes, 236, and the next highest is 223, only a slight difference, but it is one?—Certainly, that is also so.

Statistics of alcoholism and cirrhosis of liver.

490. (*Chairman.*) In 1893 there was also a slight increase in alcoholism, but not so great an increase as in neuritis and peripheral neuritis; and I see that there was an increase of alcoholism in 1900 from 81 the year before to 109?—There is an increase in everything connected with alcohol in the year 1900, an increase under alcoholism and under cirrhosis of the liver; a very marked increase.

491. (*Chairman.*) Is there any probable explanation of that?—I go on to say that this increase is most marked in the last half of the year 1900 from all these causes, and in the case of peripheral neuritis it is confined to the last half of the year. In the last twenty-six weeks of the year 37 deaths are registered from this cause, peripheral neuritis, as against eleven in the first twenty-six weeks of the year. From cirrhosis of the liver 75 deaths were registered in the second half of the year, as against 51 in the first half of the year. From chronic alcoholism, again, 66 deaths were registered in the second half of the year, as against 43 in the first half.

492. A large increase in the second half?—Yes, from all these causes. That arsenical poisoning has in each instance had to do with this increase is certain. That it is responsible for the whole of it can only be determined by the study of the Revenue returns, which will

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show whether there has been a great increase of drinking during 1899 and 1900. I mention 1899 because I take it that alcoholic poisoning is a very much slower process than arsenical poisoning, and therefore it would be necessary to go back to 1899 to study the Revenue return in that year as well as in 1900. If it can be shown that this increase in drinking did occur, arsenical poisoning will not be excluded, but it will not be possible to regard it as the sole cause of the increase in the number of deaths.

493. (*Professor Thorpe.*) Arising out of that answer, supposing it is the fact that the Revenue returns did not show that there was any great increase of drinking in Manchester and the neighbourhood during 1899 and 1900, what would be your inference then?—That these deaths were largely due to the effects of arsenic. That arsenical poisoning was going on to a large extent is quite certain from the increase in peripheral neuritis and neuritis. There can be little doubt about that, because those are the features especially associated with arsenical poisoning. With regard to chronic alcoholism, as I have already mentioned, there is good reason for believing that the medical men regarded the increase of these cases at first as really due to alcohol, and they would not be unlikely in the case of people who drink a great deal to put down the deaths to chronic alcoholism and not to the specific cause of the other symptoms. With regard to cirrhosis of the liver, that is really a somewhat difficult term to define; but cirrhosis of the liver is defined medically for the purposes of registration, I take it, by some change in the condition of the liver, partly by a certain group of symptoms, and very largely by the occurrence along with certain diseased states of the liver, of ascites, of a collection of fluid in the abdomen. The recent cases of arsenical poisoning have certainly been associated (I do not now speak from my own observation), as is stated by the best observers, with a considerable amount of effusion of liquid in the abdomen, what is called ascites. Dr. Reynolds, who has given a great deal of study to this subject, has found that in a very large proportion of these cases what is called hypertrophic cirrhosis of the liver, that is to say, cirrhosis of the liver, with enlargement and softening is present in these cases.

494. (*Sir William Church.*) Is not that rather an unusual thing in cirrhosis arising from alcoholic excess? Where you get cirrhosis and ascites is it usually hypertrophic cirrhosis or is it not rather a different form?—I understand it is the experience of the medical men in Scotland that they only get exceptionally this form of cirrhosis of the liver, and that when they do get it it is associated with beer drinking. I believe this form of cirrhosis is exceptional with the drinking of spirits. That is what I understand, but this is mere current talk on the subject. There is no specific statement on the subject that I know of except this, that experiment with animals shows that cirrhosis of the liver is not produced by ethylic alcohol or ordinary spirits. Of course that somewhat increases the probability that when you get cirrhosis of the liver associated with alcohol it is due to some irritant matter in the beer other than the alcohol.

495. My point is, is it not your experience of the profession in Manchester that the cirrhosis of the liver which leads to ascites and eventually to death perhaps, is usually of the contracted form and that there has been in the fatal cases in this epidemic an unusually large number of the hypertrophic form?—I cannot speak to that. I have had no personal experience or very little personal experience of practice in Manchester. That I cannot say. I have not in Manchester seen a single case of cirrhosis of the liver until this outbreak, but my former experience certainly was that the cirrhosis of the liver which I have seen in London and elsewhere associated with alcohol has not been of that hypertrophic character.

496. (*Dr. Whitelegge.*) Do you think of the hypertrophic kind as being associated with spirit or with beer?—With beer and not with spirit.

497. Are you thinking of it as being of rapid causation?—Do I regard it as probably of rapid causation?

498. Yes?—I should say so, but this is a little outside of my line, of course.

499. Still you have brought the medical opinion very conveniently before us?—I have followed the medical opinion on the subject, and I believe that is the medical opinion on the subject, that arsenic will of course, cause a fatty condition of the liver. How far it causes the cirrhosis is another matter. Although I have seen it stated in a medical paper that Brouardel associated cirrhosis of the liver with the effect of arsenic alone, apart from alcohol. I have not seen the original papers of Brouardel, and I can only say that I have seen that stated in a medical paper.

500. (*Sir William Church.*) The point is, and that you are clear of from what you have learned from the medical practitioners in Manchester, that many of these fatal cases of cirrhosis of the liver were of the hypertrophic form?—I have not learned that from medical practitioners but from Dr. Reynolds. I have no other authority. That is the result of his experience alone.

501. (*Chairman.*) In one of the answers you just gave you distinguished between spirits and beer. Was that opinion formed before the recent outbreak?—It was not formed by me. It is difficult to speak of another man's views, but Dr. Reynolds, I believe, has consistently maintained that peripheral neuritis at all events, was caused by beer drinking, and not by other forms of alcohol.

502. We have had Dr. Reynolds' evidence before us, and you may take it before the recent outbreak he had formed that opinion?—Long before the recent outbreak he, at all events, had formed that opinion, that is quite certain.

503. (*Sir William Church.*) Although you speak in your *précis* here of chronic alcoholism, you in your table speak of alcoholism; would that include acute alcoholism?—Yes.

504. Has there been a great increase of cases of delirium tremens in Manchester during the last year?—No; a great many of the practitioners did make remarks upon the returns which were sent in, but not one has mentioned that delirium tremens or acute alcoholism has come within his observation. Many of them stated that the patients who suffered were heavy drinkers.

505. And there has not been an increase in the number of deaths attributed to acute alcoholism, which means delirium tremens?—The return has been compiled simply as alcoholism, and I could not answer that question without going back over the register.*

Incidence of sex.

506. But the return of alcoholism would include any cases of that sort?—It would. From the analysis of the deaths in age and sex groups, it will be seen* that women died to a much greater extent than men from neuritis, with a tendency to die earlier. What might be the precise meaning of this it is somewhat difficult to say. Probably it is due in the main to the more sedentary life which women lead. It is difficult, I think, to believe that women drink more than men, or as much. It is certainly perfectly clear from observations which have been made that arsenic is largely eliminated by the skin, and I think it is probable that a great deal of the arsenic imbibed by a man is worked off in the course of his labour.

507. (*Chairman.*) So that a labourer might drink more arsenicated beer without the worst results than a woman not working in that way?—I think so. I think that is one of the explanations why the arsenic

* *Note by Witness.*—The annexed return, made from the death registers, gives the information asked for in Question 505.

Year.	Chronic Alcoholism.	Alcoholism.	Acute Alcoholism	Inquest Certificates.	
				Excessive Drinking.	Delirium Tremens.
1891 -	12	12	1	37	16*
1892 -	6	13	1	33	3
1893 -	9	17	-	47	5
1894 -	16	20	-	20	7
1895 -	6	14	-	27	8
1896 -	6	11	-	42	5
1897 -	18	26	1	25	4
1898 -	2	24	-	20	2
1899 -	10	28	1	40	
1900 -	19	49	1	33	

Five of these certified alcoholic mania.

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has affected women to so much greater an extent than it has men.

508. (*Sir William Church.*) Since we have been acquainted with what we have termed alcoholic neuritis, has it not been found to be the case, that there are more fatal cases proportionately among women than men?—Yes; that is clearly brought out——

509. I mean before this group of cases entirely, going back a good many years?—Yes. This table which I hand in is going back ten years.

510. So that the fatality among women in this epidemic has adhered to the old rule that these cases are more fatal in women than men?—Yes; that is very clearly brought out. You will see that women tend to die somewhat earlier than men.

511. (*Chairman.*) That is of neuritis?—Yes, of neuritis, simply from this cause. Then, of course, in women a smaller quantity of arsenic with the smaller frame of women would produce a greater effect, weight by weight.

512. (*Dr. Whitelegge.*) With an equal consumption?—Yes. That is to say, the same amount of arsenic will certainly produce on the average a greater effect upon women than upon men.

513. (*Sir William Church.*) What makes you say that?—Simply because they are lighter, as a mere matter of animal weight.

514. Granted that; but when used in medicinal doses, has that observation ever been made?—I do not know that it has, but we are now speaking of arsenic that we see to produce poisonous effects. When you find you are actually getting poisonous effects it is clear that a smaller amount will produce the same effect in women as in men on the average from their smaller frames. Then I think it is probable, although that would need some extensive observation, that the drink of women is more exclusively beer and stout than that of men. I think men, in addition to their beer, or perhaps instead of it, will drink more largely of spirits than women, whereas the more habitual drink of the women will be beer. Anyone who is acquainted with the side streets of these large towns knows that it is the custom to send out for a pot of beer in the afternoon, and in some parts of the town women are in the habit of meeting and having a gossip over a pot of beer.

515. (*Dr. Whitelegge.*) At home; so that they would usually get their supply of beer from the same place?—Yes.

516. Would you attach importance to that as a consideration?—Yes; I think that is not immaterial; I think it is not altogether immaterial, though I think many of the men would resort to the same place also. I think the men would mix good beer with bad to a much greater extent than women would. I do not mean to say that this is a universal or general custom in the City of Manchester for women to drink like that, but it does unquestionably prevail in certain districts.

517. The cases are more fatal among women; can you tell us what are the number of attacks of women and men—have you the figures?—No; I have no means of giving those.

and age

518. That was not one of the points of the enquiry?—No, that was not one of the points of the enquiry, I regret to say, and I have not that figure. The cases that we did collect I have given, though they cannot be supposed to bear on that. We collected histories of the illnesses of a series of 85 cases, out of which there are here details of age and sex in 77—35 men and 42 women.

CLASSIFICATION as to Age and Sex of Cases of Arsenical Poisoning observed by the Medical Officers and others, whose symptoms have been recorded. In 8 out of 85 Cases the Ages have not been ascertained.

Males.

20–29	30–39	40–49	50–59	60 and upwards
—	10	14	6	5

Total, 35.

Females.

20–29	30–39	40–49	50–59	60 and upwards.
1	17	14	9	1

Total, 42.

Both sexes, 77.

519. Those were selected cases, no doubt—not taken at random?—They were taken at random so far as going down the wards was concerned. There was no principle of selection, they were simply cases taken as they came. But that has no value, of course, for estimating the relative number of men and women affected. There is, however, this, for what it is worth, that the cases occurring among the 42 women between the ages of 30 and 40 were 17, and between 30 and 40 in men were 10, so that the whole difference was made up of the larger numbers of women between 30 and 40. The men at 60 and upwards number 5 to women 1; so that there again it would appear, taking these cases really unselected, that the women suffer at an earlier age than the men.

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520. (*Chairman.*) The illnesses presented in this table were infirmary patients?—Largely patients from the union infirmaries, and some of them from our personal observations outside the unions; but most of them from the union infirmaries. They form, of course, a permanent record of these cases. The symptoms are not very exhaustive, but they do form a permanent record of these cases. Many of them suffered from perfectly distinctive symptoms of arsenic, and I have brought this record of the cases, which perhaps the members of the Commission may like to look at.

521. These, I suppose, are the cases to which you were referring just now?—Yes.

Class of persons attacke

522. (*Chairman.*) The cases regarding which you have given information, the whole 2,000 in 1900, and the special cases, are chiefly cases of the poor treated in workhouse hospitals?—No; the number occurring in workhouse hospitals has been 550 out of 2,000, and the others would be largely poor people; but no doubt a number of them would be artisans.

523. I wished to ask that question?—Yes, respectable artisans.

524. Has this epidemic been largely prevalent among the class of respectable artisans, men employed on wages in factories, or in engineering works, or in any of the works of Manchester?—Yes; I think one may say there have been a good many cases either in men or women of that class. There is no doubt that that is so.

525. And labourers; navvies, for instance?—The labouring class, of course, have suffered more; that is, so far as the reports go. It is possible, however, that we get more information with regard to the poorest class of the population than we do with regard to artisans in a somewhat better position. I think it is likely that we do not know so much about them, but speaking from my personal knowledge of a practice of a friend, I should say we do get these cases occurring amongst the artisan class.

526. (*Mr. Cosmo Bonsor.*) Might not that be from the quality of the beer that the artisan class drink? They drink a higher class of beer, do not they?—Yes, largely.

527. It might be from that?—Yes; the better class people drink in the main a better class of beer, but I do not know that they all do. I think it is quite possible that those cheap beers are sometimes used as table beer by people in better circumstances.

528. Have exceptional sickness and deaths been due to arsenic in beer, or in other articles of food also, not solely to arsenic in beer, but to arsenic in other articles of food and drink?—The exceptional sickness and deaths noted have, so far as I can ascertain, been confined to adults, children having entirely escaped. I made particular enquiries at a very early period of the epidemic from the physicians at the Children's Hospital, and I am quite satisfied that no cases were taken there of children suffering from these conditions, nor have I heard of any children.

No arse found i sweets, etc.

529. This goes far to exclude sweets, jams, breads, etc., as sources of arsenical poisoning?—Yes, that is quite clear. Of course, children partake more freely than adults of these materials. However, in addition, a number of samples of cheap sweets and jams have been examined for arsenic, but have been found free from it in any appreciable amount.

530. Do you think that a more extensive examination of sweets, jams, and marmalades should be made? We know that glucose is largely used in jams, for instance?—Yes, we have made fairly extensive examinations. The number examined by the public analyst was 25 jams and 25 sweets obtained from a great variety of sources, and in addition, I have also examined in my office 18 samples of jams and 21 samples of cheap sweets. So that a pretty large number of jams and sweets have been examined either by the public analyst or by ourselves.

531. (*Dr. Whitelegge.*) Examined for arsenic?—Yes, examined for arsenic. I also examined three glucoses from manufacturers of cheap sweets and jams, two obtained on November 24th, and one on December 10th, the two being obtained at the very commencement, before they could well have removed anything.

532. (*Sir William Church.*) Were they free from any trace?—Yes, free from any trace of arsenic, so far as our examinations went.

533. (*Chairman.*) Is there any secret about the employment of glucose in jams and sweets?—None whatever. It is used in making honey, jams, and syrups. In fact, 9 samples of cheap syrups were submitted to the public analyst on the supposition that glucose was used in their manufacture, and all found free from arsenic.

534. (*Dr. Whitelegge.*) Did you go into the question of the origin of the sugar used in these sweets?—I did not. Of course, our time was very much taken up doing the analyses ourselves.

phocitric and ar-

535. (*Chairman.*) Is there a possibility that there might be arsenic in bottled mineral waters, for instance?—That was mentioned. It appears that an acid phosphate is made by acting upon bone ash with sulphuric acid, which is used to flavour mineral waters. It goes by the trade name of phosphocitric acid; it is really phosphoric acid. It occurred to me that perhaps it was possible we might have overlooked something of the kind, but I am now satisfied that nothing of the kind occurred in Manchester, because I know the source of the bone ash and of the sulphuric acid, and I am quite satisfied that arsenic could not have entered into that material to a poisonous extent. Not only so, but naturally the amount of this material added to the mineral waters is small, so that a very large amount of arsenic would have to be present in the phosphocitric acid, a much larger quantity than is possible in the process of manufacture, before it could produce poisonous symptoms. I think that may be dismissed as a possible source, certainly as far as Manchester is concerned.

eral r.

536. (*Chairman.*) Have ginger beers and lemonades been examined?—Yes; 22 samples of mineral waters were taken on January 21st and 22nd, and submitted to the public analyst for examination for arsenic.

537. Are ginger beers and lemonades included?—Yes, all the common mineral waters.

538. (*Mr. Cosmo Bonsor.*) Ginger ale?—Yes, ginger ale, and all the other kinds of mineral drinks.

539. Are they made from glucose?—Yes, glucose is used in the making of them. I was not thinking of that. These samples were taken simply with reference to this phosphocitric acid. At all events, they show entire freedom from arsenic.

540. (*Chairman.*) Have you any investigation of earlier samples than those referred to in the report that you now present, samples earlier than last January?—Not of mineral waters. I only learned of the possibility of this at a very late period, and I immediately requested that samples should be obtained. I admit that, even if it had been present, it would probably not have been found at so late a period as that.

541. You have no evidence of an earlier period?—I think we may conclude that it was not present in any marked deleterious quantities at any period, on account, principally, of the small quantity that could be admitted into the mineral waters.

phate of

542. (*Professor Thorpe.*) Perhaps you have learned from what has appeared in the medical papers that there have been one or two very serious cases of poisoning by medicated or aerated drinks, in which phosphate of soda has entered, which phosphate of soda has been found to contain arsenic?—I have not learned that.

543. I thought possibly it was that fact which had led you to go on and search mineral waters; but you were not aware of that fact?—I was not aware of that.

ons attd drank per ties of

544. (*Chairman.*) So far as the observations made at the union infirmaries and other public institutions go, and so far as the testimony of Manchester practitioners go, may we take it that the symptoms of arsenical poisoning have been confined to persons drinking beer and stout almost exclusively of the cheaper qualities?—Yes, I say that the exceptions to this statement are trivial. In fact, I have only heard of two possible exceptions. One of these was associated with the drinking of a better class of beer, which I had the opportunity of analysing, and which presented the merest trace of arsenic. It was so small that it was impossible to determine the amount with the quantities used. The other case that I have heard of was in connection with drinking wines of a better class.

545. Was arsenic found in the wine?—I do not know. I cannot speak as to that. I may mention that I have recently—February 22nd—obtained six samples of cheap wines, two of port, two of Burgundy, and two of claret, but have found no arsenic present according to the ordinary Reinsch's test.

546. Is there any explanation why it should be in the cheaper qualities of beer that arsenic is found? Is glucose used in high-class beer?—Yes. That is due, no doubt, to the proportion of glucose which has been used in the production of this beer.

547. Is there a larger proportion of glucose in the cheap beers?—Yes, and invert sugars are also used in the production of this beer.

Persons who denied drinking beer.

548. (*Dr. Whitelegge.*) Have you particulars of any case of peripheral neuritis in which there was no consumption of beer at all?—I believe in one of the cases there was something about that. It is page 19 of my report, No. 80 of the cases. The case is recorded in full in the papers I have just handed in. I am afraid I put no stress upon that. This patient was 47 years old. The notes are very scanty. The early symptoms of the illness were nausea, vomiting in the morning, pains in the hands and feet and on pressure of the calf, and slight difficulty in walking. The present symptoms, as observed by the physician at the hospital (this is Ancoats hospital) are that the patient has slight difficulty in walking, dilatation of the right side of heart, pain and redness in the soles of the feet, excessive sweating of the hands and feet, eruptions, slight ichthyosis, that is thickening of the skin, peeling, or desquamation of the skin. This patient denies having taken beer. I know the street in Ancoats from which this patient comes, and I think it would not be well to attach an undue degree of importance to the statement that this patient has never taken beer.

549. (*Sir William Church.*) Those symptoms are just the ones we used to attribute to alcohol; she apparently had no pigmentation, there was something of an eruption, but we are not told the character of the eruption?—That is so. Those are just the symptoms which were formerly ascribed to taking alcohol. I think in one or two isolated instances the statement that no beer had been taken should be received with great caution.

550. (*Chairman.*) Did this case end fatally?—No; she recovered, I believe.

Brewery hands affected.

551. (*Sir William Church.*) Was there a large number of cases of peripheral neuritis observed among the employés of the breweries in Manchester?—I believe so, but I do not know that of my own knowledge. I know it of one large brewery, because I had a conversation with the brewer upon the subject. This brewery, however, was not in Manchester.

552. One would rather expect that there should be a marked difference between the employés of the breweries that used a large quantity of the probably deleterious sugars, and those which used a less quantity. You would have thought their employés would have been the first people to suffer?—That depends very largely on the amount of beer they are allowed to take. In this particular brewery it was a very marked feature, but that, I think, you have probably already had.

553. Do you mean the amount of illness?—In one particular brewery, not a Manchester brewery.

554. (*Sir William Church.*) We have not had any evidence yet associating outbreaks of the disease with breweries so far as their employés are concerned?—Well, I believe that in one brewery a number of workmen did have symptoms of arsenical poisoning.

555. (*Dr. Whitelegge.*) Have you the particulars of the employment of the men who suffered from this? Shall we find in the notes you have brought to us particulars of the employment?—No. Of course, so far as the deaths are concerned, I think it could be easily obtained. I have handed in the paper of additional statistics of the deaths, and if it is not upon that list it could very easily be obtained. (See Appendix, No. 4, Table D.) May I say that my efforts, so far as they concern investigation in this matter, were directed to determining whether the poisoning arising from the consumption of beer and stout was due to glucose and invert sugar from which it was made, or whether it was due to other ingredients in the beer, and that the notes which I have brought were collected, arranged, and classified mainly with that object.

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555. (*Chairman.*) In many cases you have been able to trace the beers habitually used by the patients to the breweries producing them?—Yes, a very large number of these people got their beer, or most of it, habitually from one place, or if not from one place, from two or three places. Sometimes, of course, they used a great deal at their work, and then they go to a particular place, or they have a good deal at home, and they have another place. We obtained from each patient visited a statement of the public-house or public-houses from which their beer was obtained, and what particular kind of beer they used. In a number of instances the patients were able to tell us what precise brewery it was that produced the beers they used, but in a number of others all they could tell us was the kind of beer and the public-houses which they frequented. In those instances the Inspectors of Food and Drugs visited the public-houses, where necessary, and ascertained the precise beer which had been consumed, so that in 63 out of the 85 cases collected we were able to ascertain exactly what brewers the beers and stouts which these patients habitually consumed came from.

Beer consumption of 5 Manchester cases.

557. Had the brewery in each case used Bostock sugar?—Yes. I have constructed a table, which is on pages 16 and 17 of my Report to the Sanitary Committee of the Manchester Town Council, which you have before you, showing the connection of the cases with the sources of arsenical poisoning.

Implicated breweries customers Bostock.

SUMMARY of 85 Cases, showing their connection with sources of Arsenical Poisoning.

No. of Case.	Beer subsequently taken from public-house frequented, shown to contain arsenic. A.	Sugar obtained from brewery, whose beers were consumed by the patient, proved to contain arsenic. C.	Arsenical sugar supplied to brewery, the beer from which was used. C.	Beer from the same brewery obtained at public-houses shown to contain arsenic. B.
1	—	—	†	†
2	—	— †	† †	† †
3	—	†	†	—
4	—	—	†	—
5	—	— †	† †	— —
6	—	†	†	†
7	Name of brewery not obtained.			
8	Do.			
9	Do.			
10	—	†	†	
11	Name of brewery not obtained.			
12	—	†	†	†
13	—	†	†	†
14	Name of brewery not obtained.			
15	—	†	†	†
16	—	†	†	†
17	Name of brewery not obtained.			
18	General drinker.			
19	Patient moribund.			
20	Brewer not ascertained.			
21	—	†	†	†
22	—	† †	† †	† †
23	—	†	†	†
24	Brewer not ascertained.			
25	—	†	†	†
26	—	†	†	†
27	—	†	†	†
28	—	†	†	†
29	—	†	†	†
30	—	†	†	†
31	General drinker.			
32	—	— in part	† in part	†
33	General drinker.			
34	—	— † † —	† † † †	† † † †
35	General drinker.			
36	—	—	†	†
37	—	†	†	†
38	—	†	†	†
39	—	†	†	†
40	—	—	†	†
41	—	†	†	—
42	—	† — —	† † —	† † —
43	—	† in part	†	†
44	—	† in part	†	†
45	General drinker.			
46	Do.			
47	Brewery unknown.			
48	—	†	†	—
49	—	—	† in part	†
50	General drinker.			
51	Brewer not stated.			
52	—	† †	† †	— —
53	Brewery not stated.			
54	—	—	†	—
55	—	†	†	†
56	†	—	†	†
57	†	†	†	†
58	†	—	†	†
59	† †	†	†	†
60	†	†	†	†
61	—	† †	† †	— †
62	—	†	†	†
63	—	—	†	†
64	Brewer not ascertained.			
65	—	†	†	—
66	—	†	†	†
67	—	†	†	†
68	—	†	†	†
69	—	†	†	†
70	† very slight case	—	†	†
71	† from brewer	—	†	†
72	—	—	†	†
73	—	—	†	†
74	—	†	†	†
75	—	†	†	†
76	—	†	†	†
77	—	†	†	†
78	—	—	†	†
79	—	— †	† †	† †
80	— said not to have taken beer.			
81	—	†	†	†
82	—	†	†	†
83	—	†	†	†
84	— brewery not known.			† in part.
85	—	†	†	†

In the above table the sign † indicates that the presence of arsenic in appreciable amount was detected in the article named in the column under which it stands; the sign — that it was not so detected. When in any column there are two signs, such as — †, this means that the patient used two beers, and that of the materials in the column in one arsenic was not found, while in the other it was.

553. The breweries here are marked by letters, but the Commission would like to know the names of the brewers?—I have not the key here, but I can send the names to you.

559. Perhaps you will send the names to Dr. Buchanan?—I will send the names.

560. You have ascertained that the Bostock sugars were used in a considerable proportion of the Manchester breweries?—I ascertained that in every instance. From the list supplied to me by Dr. Tattersall, which he obtained direct from Messrs. Bostock of Garston, I ascertained which Manchester brewers were obtaining their sugars, and in one case I ascertained directly at the brewery. I found that 12 out of 23 Manchester breweries had been obtaining Bostock sugars or inverts, and I found that in every one of these cases, which are recorded in that table, the brewery whose beers or stouts the patients had consumed had received the incriminated sugars or inverts—in every instance.

561. Is 23 the whole number of the Manchester breweries?—Yes, the whole number I have ascertained.

562. But there are more breweries than 23?—I think not.

563. There were 23 breweries and 12 out of the 23 had the incriminated sugars?—Yes.

564. (*Dr. Whitelegge.*) Are those 12 breweries in Manchester or supplying Manchester?—The breweries referred to as having furnished beer to 63 cases are not all in Manchester; two of them are not in Manchester. That would make 14 out of 25. There are two other brewers incriminated in this list.

565. (*Chairman.*) 14 out of 25; there being 12 out of 23 in Manchester?—Yes.

566. In those cases was beer from the same brewery obtained at publichouses other than those frequented by the patient found to contain arsenic in an appreciable amount?—55 out of the 63 beers taken either at publichouses supplied with the same beers which the patients consumed, or at the publichouses which they frequented, contained arsenic.

567. I think, having traced it to the brewery, you followed it back to the publichouses other than those frequented by the patient?—Yes, with the exception that in 7 instances the beer from the same publichouse was followed up, and the beer was found to contain arsenic.

568. What was the highest amount of arsenic ascertained?—The highest amount which we have ascertained has been about half a grain per gallon. Perhaps you will allow me to explain precisely what steps we took which will lead up to a statement of these samples. The day after Dr. Reynolds informed me that arsenic had been found in beer, having ascertained from him the breweries from which patients were stated to have got their beer at the infirmary, I got 12 samples of beer taken and submitted to the public analyst. It was, however, some time before the Public Analyst declared the presence of arsenic in the beer, and meantime it had been discovered to be present in the glucose. A meeting of the Sanitary Committee took place on November 28th, at which it was deemed advisable by the Committee to issue a public announcement that action would be taken in the case of any beers found in publichouses to contain arsenic. This announcement was, I presume, made in order that the publicans might have guilty knowledge of the presence of arsenic in his beer, so that he might be made aware formally and officially of the possibility that his beer might contain arsenic.

569. (*Dr. Whitelegge.*) Bringing him under Section 3?—That should, of course, have the further effect of bringing him under Section 3 of the Sale of Food and Drugs Act of 1875. After that we proceeded to take a number of samples, with the view purely of administration. 85 samples of beer were collected and examined by us, and of these 55 were found not to contain arsenic. That is a matter not very easy to settle if they do not show any trace of arsenic.

570. (*Chairman.*) By the Reinsch test?—In the preliminary stage of the Reinsch test, in the darkening of the copper. The darkening of the copper in the Reinsch test proves nothing, but the absence of it shows that arsenic is not present. In those that did darken further official samples were taken and submitted to the Public Analyst to the number, I think, of 27, and 25 of these have been declared by the Public Analyst to contain arsenic in the varying quantities.

571. (*Dr. Whitelegge.*) What was his report on the earlier samples?—Do you wish the exact amount?

572. Did the Public Analyst find arsenic in the earlier samples you submitted to him?—Yes, in 11 out of the 12. I will give you the full particulars of all the analyses which have been made.

573. (*Chairman.*) From these analyses, and from all the analyses that have come under your observation, do you find that large amounts of arsenic could only have been derived from the arsenical glucoses and inverts?—That is the conclusion to which one comes from the examination of those beers, and I may say also from subsequent published analyses of malts, and from the examination of malts which we have ourselves made.

574. Those cases were all taken after the 28th of November?—They were all taken after the 28th of November, after the Sanitary Committee had issued the notice.

575. Were the 81 samples taken after the 28th of November?—Yes, so far as our examinations go the particulars of these examinations are given at pages 28 and 29 of the Report which has been handed in.

576. Some samples, I see, were taken for another set of analyses about November the 20th?—Yes, the first set of samples were taken on the 21st of November. From these samples a number of summonses have been taken out against the publicans; I think the total number of summonses taken out has been 35.

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Prosecutions of Publicans.

577. (*Dr. Whitelegge.*) All against publicans?—Yes.

578. None against brewers?—I do not know that it was possible to take any other action.

579. (*Chairman.*) And have those summonses all had effect now, or are they pending?—Only one has been heard, and that summons is pending. The summons was taken out under Section 6 of the Food and Drugs Act, the charge being, "Selling to the prejudice of the purchaser beer not of the nature, substance, and quality demanded." The stipendary magistrate, Mr. Headlam, gave his decision in favour of the Corporation, and convicted the defendant, fining him 40s. and costs, but the opposing barrister asked the magistrate to state a case as to whether these cases properly come under Section 6 of the Sale of Food and Drugs Act. That case is now under the consideration of the King's Bench Division. (*See footnote to page* 13.)

580. (*Dr. Whitelegge.*) What was the amount of arsenic found in that?—One-eighth of a grain per gallon.

581. (*Chairman.*) And the other 34 summonses have not yet been acted upon?—They are not. They are waiting for that decision.

582. (*Dr. Whitelegge.*) Were they all taken under the same section?—Yes.

583. (*Chairman.*) And when is it likely to come on in the King's Bench?—I believe the decision is expected now. I think within a week or two at the outside the decision should be given.

584. On that decision much may depend in respect to the necessity for fresh legislation?—Yes, decidedly; I should say so.

585. (*Sir William Church.*) If this decision is not upheld by the King's Bench you would have no power of restraining the defendant from going on selling the beer, would you?—Then if you could get a sample containing arsenic you could proceed under Section 3 of the Sale of Food and Drugs Act.

586. (*Chairman.*) Section 3 mentions articles deleterious to the health?—Yes.

Application of Section III. of F. and D. Act.

587. Section 6 was the other section?—Yes, selling to the prejudice of the purchaser.

588. Beer adulterated with water would come under Section 6?—It would.

589. Were no summonses taken out under Section 3?—I think not, but I have not to do with that part of the business. In fact, I am sure they were not.

590. Can you suggest any reason why Section 3 was not chosen, that being, of course, in your department, a danger to health?—No, I do not know the reasons. That is the department of the Town Clerk, and I do not know what the reasons were.*

591. (*Professor Thorpe.*) You told the Commission that your sanitary authority met and purposely gave warning to these people in order to bring them into the operation of that section?—I do not say that was the reason it was given; it would, of course, have that effect, but I do not say that was the reason.

592. I think that was the answer you gave to Dr. Whitelegge, that it was to bring them within Section 3?—I should like to qualify that by saying that would be the effect of it. Of course I do not know what the object of the Sanitary Committee was in giving that. I do not think the Sanitary Committee in issuing that notice discussed the question of whether the cases would come under any particular section of the Sale of Food and Drugs Act. That was not under discussion at the meeting.†

593. (*Chairman.*) Was arsenious acid introduced into the glucose by the process of conversion?—By the process of converting the starchy matters by the use of contaminated sulphuric acid, and into the invert sugars in the same way.

594. You do not think it possible that the arsenic may have come in the starch, or in some of the other materials

* *Note by Witness.*—Summonses, I am informed, were applied for under Section 3, but on the advice of the Stipendary Magistrate, were not taken out.

† A chief reason for taking this action was the desire to cause as rapid a withdrawal of arsenical beer as possible.

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used, grain, or sago, or rice?—I do not think that is possible. We did examine one sample of starchy matter, but we have not examined a number of different flours and starches.

595. We know for certain it was introduced by contaminated sulphuric acid in some of the cases; do you consider it was probable that it was introduced in that way in all the cases?—I should take the negative results as very conclusive in regard to a number of these matters; you find a large number of beers which are quite free from arsenic, and in which precisely the same materials otherwise are used as regards starches. For instance crude grain or rolled rice are introduced into the mash tun, but there is no evidence that these materials lead to the presence of arsenic in the beer. The same remark, for instance, would apply to water. The fact that a large number of beers are made from the same water that contains no arsenic shows conclusively that the water of itself could not introduce any material amount of arsenic. A number of materials can be excluded in that manner, and we know that the arsenic was present in the glucose to a very large amount.

Arsenic in malt

596. Has arsenious acid been found in malt?—Yes.

597. Was it found in amounts sufficient to account for any arsenical poisoning?—I think not in any amount sufficient to account for an outburst such as has recently occurred; but I should not say that the amount found in malt in each case amounted to more than the equivalent of 1-25th of a grain per gallon.

598. Do you think that a slow process of poisoning might not result from such an amount of arsenic?—I think that is quite possible.

599. So that malt is in itself a danger which in some cases may be serious?—Yes, I think so. I think we must regard the presence of arsenic in those amounts in malt as a distinct danger, and as possibly leading to the slow form of arsenical poisoning.

Quantity of beer consumed by sufferers

600. Do you think that the comparatively small, but still decided amount of symptoms of neuritis which might be arsenical prior to the recent outbreak, might have been due to malts?—Yes, I do, indeed. I think that is extremely probable, and the high degree of probability which attaches to this will depend partly, I think, upon the amounts of the poisoned beer, which we find that patients consumed who suffered in the recent outbreak. I give on pages 10, 11, 12, and 13 of my report the results of what we ascertained with regard to the amounts of beer stated to have been consumed by persons suffering from well-marked arsenical poisoning, all the cases at the bottom of page 10 having distinct pigmentation with one exception, as follows:—

Amounts of Beer or Stout used daily.	Sex.	Amounts of Beer or Stout used daily.	Sex.
3 or 4 glasses	*f*	4 or 5 glasses	*m*
Heavy drinker	*f*	8 to 10 glasses	*m*
4 or 5 glasses	*f*	Large quantities	*f*
Heavy drinker	*f*	Large quantities	*f*
3 or 4 glasses	*f*	1½ pints	*f*
2 glasses	*f*	4½ pints	*f*
3 or 4 glasses	*f*	1 pint	*f*
5 or 6 glasses	*m*	(Well-marked case, though no pigmentation)	
2 or 3 glasses	*m*		
(Probably much more)			
4 or 5 glasses	*m*	1½ pints	*f*
8 or 10 glasses	*m*	(Deep pigmentation)	
4 or 5 pints	*m*	2 pints	*f*
10 to 12 glasses	*m*	Heavy drinker since August last.	*m*
10 to 12 glasses	*m*		
12 glasses	*m*	3 or 4 pints	*m*
5 or 6 pints	*m*	Heavy drinker	*m*
8 or 9 glasses	*m*		

On the following pages I give the entirely spontaneous remarks of a number of practitioners upon that point, and instances which many of them give of small quantities of beer producing definite illness.

601. (*Sir William Hart-Dyke.*) Had these cases at the bottom of page 10 of your Report been drinking the beer which was proved to have been made from glucoses, or are they cases picked out at haphazard?—These are cases included in the 63 I have given detailed notes of, all of which had been drinking beer made with arsenical glucoses and inverts; so that all these also had been taking the poisoned beers. You will see that in some instances the quantities are surprisingly small. Of course a certain amount of allowance has to be made in the case of statements made by people as to the amount which they consume, but the aggregate effect of these statements I think is to show that a very small amount, perhaps two or three glasses of beer a day, have produced decidedly poisonous effects.

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small qu tities in cases.

602. (*Chairman.*) I see in one case a single pint of draught beer for supper each night is the amount stated?—Yes, and in a case which may be relied upon as regards the amount of beer, I may mention that a doctor had suffered from slight numbness and tingling in his fingers and some dulling of the sense of touch from the consumption of one glass of beer daily at meals. There is a doubt there as to whether this was arsenical poisoning, but I am inclined to believe that possibly it was, without attaching too much importance to it. I think it is possible it was a case of that nature. He was a very intelligent observer who made this observation, and absolutely to be relied upon, and his impression was that on stopping beer—he ascribed it to the use of the beer he was taking—the symptoms disappeared.

603. (*Chairman.*) Was this arsenical?—He did not know.

604. (*Professor Thorpe.*) Was this before the scare?—Yes.

605. (*Chairman.*) It would take a very large quantity of arsenic per gallon to allow one pint daily to have any injurious effect, would it not?—One-twentieth of a grain per gallon, for instance, a pint is one-eighth of a gallon, and if you take one-eighth it would be one-sixtieth of a grain per day—day after day, month after month; would that be injurious?—Yes, I think so. We know there has been half a grain in some cases. That is quite certain; indeed, in Liverpool, and also in exceptional instances in Manchester, they have found as much as a grain and a-half per gallon, so that one-eighth part of three halves is three-sixteenths of a grain, nearly one-fifth of a grain.

606. Would that be a large medicinal dose?—Yes; and I think quite capable of producing marked symptoms.

607. And taken day after day might be fatal, or very injurious?—It would be very injurious, certainly. One does not like to go too far, but that certainly might be so in susceptible people. Arsenic affects people very differently; the degree of susceptibility to arsenic, that is to say, the power of eliminating arsenic from the system, varies apparently enormously.

Indivi susceptibility t enic.

608. Are cases known in this country such as those recorded of Styrian peasants who take large quantities of arsenic, getting accustomed to it, and increasing the dose?—I know of no such instance, but I think a great many people drink enormous quantities of beer; brewers' draymen, for instance; and there is no question that a large number of these men have escaped entirely. I presume, therefore, that their systems have in many instances proved capable of coping with the amount of poison they have consumed. The power of eliminating arsenic varies very greatly, a fact well-known before the recent outbreak. The very small quantities which in particular instances have produced symptoms makes it highly probable that in susceptible persons the amount of arsenic capable of being introduced by the malts which have been examined in Manchester would be capable of producing slow arsenical poisoning.

No ar should permi any b mater

609. So that it is really necessary to look more carefully to the malt than has hitherto been done?—I think no arsenic is permissible in any brewing materials. There is no occasion for it. It is quite possible to obtain brewing materials for all practical purposes entirely free from arsenic, and there is no occasion why arsenic should be introduced.

610. (*Sir William Hart Dyke.*) You mean by proper processes?—Yes, by proper processes and methods.

611. (*Chairman.*) And would you consider that malt that requires brushing and screening to remove arsenic from it to be safe?—If it could be proved that the brushing and screening were effective in removing all the arsenic, I do not know why one should not. But I should want to have the means of examining the malt and proving it was free from arsenic after the processes were completed.

612. It may be doubtful whether if it has been there at all, brushing and screening could sufficiently purify it?—Yes. I think that malt should reach the brewer without any arsenic with it.

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613. (*Professor Thorpe.*) How does the arsenic get into the malt?—The arsenic gets on the malt by the process of kilning. On page 45 of my report I show by going over the materials taken from a maltings step by step that you get no arsenic upon the grain before it is placed on the kiln floor.

614. You mean to imply that the arsenic gets on to the malt from the coke or material which dries it?—Yes; it is deposited from the fumes coming off from the fire underneath, whether anthracite or coke.

615. Then the proper treatment would be to take care there was no arsenic in the coke or the anthracite used?—So far as that is possible that is the first requisite. It is, however, difficult to obtain fuel which is absolutely free from arsenic. Still with proper choice of fuel I have no doubt that very little arsenic need be deposited. I think, however, it is essential that what is deposited should be removed. I understand that there are various ways of kilndrying, one being to kiln-dry without admitting the vapours from the fire to the grain at all.

616. (*Chairman.*) That seems reasonable, and it seems hardly necessary that arsenic should get on the malt?—That would entirely prevent the arsenic on the grain.

617. (*Sir William Church.*) You are not conversant enough with practical malting to say what difficulty there is in drying the malt in drums?—I am not in a position to speak to that subject. I have not seen a kiln of that description. I presume it is largely a matter of expense. I cannot say what the practical disadvantages or disabilities of kiln drying without passing the fumes up through the floor, are.

n-dried

618. (*Dr. Whitelegge.*) You say at page 45 that "It thus appears that part of the grain arrives with arsenic on it, possibly foreign grain kiln dried to make it keep"?—I received a letter afterwards saying that very possibly the cleaning screens had been used for the malt, which is mentioned in the report. I was assured before, that it was not so. There is no doubt that arsenic is deposited on the grain in the process of kiln drying, that I ascertained by getting grain which had been kiln-dried at the maltings, but the arsenic so deposited is removed in the steeping tank, and carried away by the water, so that when the grain proceeds to sprout, and before it is placed on the kiln floor, there is no arsenic on it, or at any rate not sufficient for us to ascertain.

p-.

619. (*Chairman.*) Then does hops ever get contaminated in the drying or otherwise?—I give on pages 37, 38, 39 and 40 of the report, the result of the examination of brewing materials, from which it will be seen on page 38, line 3, that a solution from 16 grammes of hops in one instance, and page 39, line 2, a solution from 12 grammes in another instance, yielded a very small amount of arsenic, so that it is manifest that arsenic does in some instances get on the hops. I am not familiar with the process of hop curing, but I understand that sulphurous acid is used in the drying of hops. If an impure sulphur were used, which is possible, a certain amount of arsenic would be deposited on the hops, and as hops are a very light material, of course in proportion to the weight, there would be more than there would be on a heavy material such as malt.

620. Does that coloration by sulphurous acid affect the quality of the hop flavour?—I do not know that it does, and I do not know that it very much affects the quality of the beer, because the amount which can get in in that way is so trifling. I understand that in the qualities of beer which have given rise to these arsenical cases, the amount of hops may average something like 1½lbs. to a barrel of beer.

621. (*Sir William Church.*) Thirty-six gallons?—Yes, 36 gallons. That is 1½ to 360 lbs., and if the amount of arsenic that could be present in the hops is reckoned up, it would appear that the amount that could be introduced in that way is too small to produce any danger.

622. (*Sir William Hart-Dyke.*) It would be infinitesimal?—Yes. It is not an important matter. Still all the same, I do not say that any brewing should contain arsenic. We do not know in what form arsenic is present in beer; we do not know that it is present as arsenious acid; it is quite possible that it is present as a more poisonous combination, such as arsenic is nothing else than a mechanical action. You bination, but a compound of arsenic with an ethyl radical—and that being the case I think it will be necessary to insist that no arsenic should be present in brewing materials.

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623. (*Professor Thorpe.*) You have no evidence of arsenic in any other form than arsenious acid in beer?—There is no direct evidence. I am not a chemist, and I have to proceed largely on what I found recorded in treatises on the subject, and I see that it is believed that arsenic in wall-papers produces its poisonous effects in some form, which is more highly poisonous than arsenious acid, and that it assumes this form in presence of fungi which grow on the wall-papers. Now what is possible with wall-papers is possible with beer, the more so that these cheaper beers are very readily overgrown with fungi of various descriptions, and I think, therefore, that there is inherently at all events a possibility that arsenic may exist in these beers in a more poisonous form than arsenious acid.

Form in which arsenic present in beer.

624. You are reasoning solely from the analogy of the wall-paper?—Not entirely. There have been peculiar features in these arsenical cases. It has been noted by all the physicians that there has been a marked absence in many cases of lachrymation, which is a distinguishing feature of poison by arsenious oxide, and also that there has been in many cases a singular absence of gastric symptoms, of sickness and vomiting, which is also an early feature of cases of arsenical poisoning. That also suggests—I would not like to say more—that the arsenic may be present in some form other than arsenious oxide.

625. I think perhaps we had better dispose of this question. In the question of the poisoning by wall-paper, the presumption is that the poisonous acid is due to arsine or diethyl arsine, and that these arsines are formed by the fungoid growth of which you speak, which are supposed to give off small quantities of hydrogen; and it is this nascent hydrogen, in contact with Scheele's green, where Scheele's green has been used, or the arsenious oxide which has been used as a dressing for the paper, which gives rise to these volatile arseniated compounds. You have in the case of wall-paper, which occasions their presence, a curious garlic odour. That is a condition of things that cannot obtain in the case of beer. There is no similar action in any fermenting process concerned with beer, and therefore there is no possibility of anything in the nature of these arsines being formed?—I scarcely like to enter into that after a distinguished chemist has spoken on the subject. I have not personally any knowledge of beer having a garlic odour or taste.

626. (*Chairman.*) Is a garlic odour ever manifested in the breath in any of these cases?—I have not heard of anything of that kind.

627. I see yeast is mentioned also as a substance in which arsenic is found. You mention it at page 38 of your report?—Yes, it was quite manifest that yeast shows a distinct power of picking up arsenic from a liquor which it is used to ferment.

Arsenic in yeast.

628. I see in the only two cases mentioned that they both contained a considerable amount of arsenic?—Yes. I give the examination on pages 41 and 42 of a number of yeasts, all of them, it will be seen, containing arsenic, and some of them yield when 50 grammes of the yeast are examined large crystals of arsenic; that is to say, they contain a large amount. The quantity, however, has not been exactly estimated.

629. Is this yeast which has been used in brewing from arsenicated glucose?—These were yeasts to be obtained from current brews from December 29th to January 3rd of this year. They were obtained from the breweries.

630. From breweries where the incriminated sugar had been used?—Some were, and some were not. But all those that contain a large amount of arsenic, with one exception, were from breweries which had used the incriminated sugars.

631. Is there any other source known from which the yeast could acquire arsenic?—Yes, from the malt and hops. In these the amounts are, by comparison, small, but it is manifest that supposing yeast to have the power of picking out arsenic from the liquor to be fermented, if a material is put in which is capable of yielding 1-25th of a grain per gallon the yeast will have arsenic presented to it in sufficient amount to allow it to pick out a fair amount.

Affinity of yeast for arsenic.

632. (*Professor Thorpe.*) Is it not conceivable that the so-called selective action of the yeast in picking out the arsenic ethyl. I do not know the exact chemical com-

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have, for example, arsenicated malt; the wort, of course, contains a solution of arsenious acid. You add to the liquor the hops, and then the fermentation proceeds. The effect of that of course is that if the hops by any chance contain sulphur, which they very frequently do, there would be a precipitate of arsenic sulphide upon the yeast. Therefore, yeast does not so much take it out by any power of the yeast organism, but it is a simple deposition of the insoluble arsenic sulphide on the yeast material. Is not that a conceivable possibility? Is it not inconceivable that the yeast itself should have this selective action? The yeast plant would not necessarily take away arsenic; it does not select arsenic; arsenic is not food for the yeast. I simply want to put it to you whether it is not conceivable that the arsenic sulphide, which is a big insoluble substance, is deposited on the yeast?—Could the sulphide of arsenic be formed in that manner?

633. Yes?—Simply from the presence of sulphur?

634. Certainly. Sulphuretted products are formed by the action of the sulphur which is on the hops; if you boil sulphur with arsenious oxide you will get sulphide of arsenic?—Would the mere presence of sulphur suffice to lead to the deposition of sulphide of arsenic from a solution of arsenious oxide?

635. That is my suggestion?—That is a matter which could be very easily determined experimentally. It has not occurred to me to do it.

636. I venture to say that is a more probable reason than the so-called selective action of the yeast. I do not believe in the selective action, but I think I see how the yeast would mechanically act by collecting a precipitate of arsenious sulphide?—I do not know that that occurs, but now it has been suggested it is very easy to put it to the test and settle experimentally whether that deposit does occur. I do not know, as a matter of fact, that such a reaction takes place. I should have thought it would lead to a cloudiness in the liquid which would be noticed by the brewer.

637. But beer is cloudy, is it not, in fermentation?—I mean before the yeast is added. But I think I should prefer to leave the subject of yeast to a gentleman who is more profoundly acquainted with it than I am. My knowledge of yeast is somewhat superficial, but it is a subject which no doubt the Commission will have the opportunity of going very deeply into, and I should prefer not to say very much about it. I have heard suggestions made that arsenic could take a vital part in cell growth; but I really know so little about it that I do not wish to say anything. It is possible that what Professor Thorpe has suggested is the fact, but I do not know that such a reaction occurs, and I should prefer simply to say that it is undoubtedly true that yeast does pick out the arsenic in some way or other from the fermenting liquor.

638. (*Chairman.*) That seems to prove that great care should be exercised in respect to the yeast as one of the ingredients used in brewing?—Yes, unquestionably; in transferring yeast from one brewer to the other, but it is quite evident that if the brewing materials are free from arsenic, viz., sugar, malt, and hops, even if arsenic is present in the yeast to begin with, it will very soon disappear, because the yeast multiplies in each fresh brew, and the arsenic, being a metal, does not multiply, so that that would clear itself. Still, there is a danger, I think, of arsenic being transferred from one brewery to another in the exchange of yeasts which contain a very much larger amount of arsenic than the liquor from which they are made.

Action of M.O.H. in consequence of epidemic.

639. (*Sir William Hart-Dyke.*) How many years have you been medical officer in Manchester?—About seven years.

640. And your responsibilities extend over a very large population?—Yes, 550,000.

641. And, of course, one of the most responsible charges laid upon you is looking after the possibility of poison entering into the food or the drink of the people?—I do not regularly administer the sale of Food and Drugs Act, but naturally the responsibility does devolve upon me of looking after it.

642. There would be an indirect responsibility; that is to say, where you noticed any alarming symptom of an epidemic, or anything peculiar in certain deaths in the district, you would take steps with regard to it at once?—Yes.

643. You would see a full investigation took place?—Yes, if I perceived that. But I think perhaps I might refer you to the table already handed in. (*Appendix No. 3.*) You will see there was not very much out of the usual occurring. Up to the fortieth week in 1900 there was absolutely nothing, and after that the difference in the number of deaths ascribed to peripheral neuritis was so slight that it might very easily escape one's attention, or be put down to the peculiarities of some practitioner.

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644. With regard to glucose, of course, you have been aware for a long period that glucose was extensively used, not only as regards the manufacture of beer, but in the manufacture of jams and other articles of food?—Yes, I have been quite aware of that.

645. It was a matter of common notoriety, and you had special reason to know of its use. Had any suspicion ever passed through your mind before as to the possibility of danger lurking in glucose?—I cannot say there had. I am afraid I have accepted that along with a great many other things. It is quite evident that a great many children take a good deal of glucose as cheap sweets. I was quite familiar with the manufacture of cheap sweets from glucose. I think it is a question which may be reasonably a subject for scientific inquiry how far glucose as an article of food is equivalent to sugar, but I do not think there is anything which would justify one in saying that glucose or invert sugar are not fit articles of food.

646. But you think the question of most imminent importance to be the one as regards beer at this moment?—Distinctly.

647. I apprehend you are also of opinion that the sooner this enquiry now proceeding results in some procedure on the part of the Legislature or otherwise to secure the public the better?—Yes; I think it is desirable that every possible means should be taken to protect the public from another occurrence of a similar nature.

643. And you have no doubt, of course, as to the precise cause of this epidemic at Manchester—you have no doubt whatever as to what it is attributable?—None whatever.

649. You had two processes of examination—that is to say, you examined in a number of cases the glucose and invert sugar in these substances, and also examined the beer itself?—Yes.

650. Did you examine some 45?—Yes. A qualitative examination was made of most of the glucoses. You will see that an analysis is given of the glucose as furnished to me from all the brewers in Manchester on p. 23 of my report, and that all these failed to give any reaction suggesting arsenic except the glucoses and inverts from Messrs. Bostock.

651. Is it much more difficult to ascertain the presence of arsenic in the completed material of beer than in a substance like glucose?—No, I should not say it was. I should say Reinsch's test is particularly good.

652. Is it possible it might exist in the beer and escape detection, whereas it would not escape detection in the glucose?—No, I think not.

653. In part of your report you rather suggest that it is quite possible that disease in some degree may have emanated from the consumption of beer in years past, and escaped the notice of medical men in your district?—Yes.

Arsenic in beer before 1900.

654. You say, "The suggestion is that there may have been arsenic present in the beer formerly. There is, indeed, reason to suspect that the same phenomena"—that is to say, indications of disease—"may have been going on for years, though in a slighter degree"?—Yes, that is so. I gather that in various ways. One of the reasons is that it is a matter of ordinary comment that physicians coming from Scotland find an amount of peripheral neuritis in Manchester which they do not find in Scotland. They find a very small number by comparison in Scotland. One also hears there are very few cases to be seen in the London hospitals by comparison with what is seen in the Manchester hospitals. Then I do not think there is any adequate security that sulphuric acid containing arsenic has not been previously used in the manufacture of glucose and inverts. Doubtless it has not contained arsenic to such an extent as the sulphuric acid in recent use.

655. Do you think it is possible that medical practitioners have not distinguished between disease which has been caused by excess of drinking or consumption of alcohol, whether in beer or otherwise, and that caused by imbibing small quantities of arsenic daily?—They have not distinguished them. I do not think in the

majority of cases it is possible to distinguish, except by the history of arsenical poisoning.

656. With regard to the process of making beer which you refer to, you compare the different dangers which may ensue, whether from the use of invert sugar, glucose, or malt, from the presence of arsenic in either; are you prepared to state that it would be less danger as regards arsenic getting into beer through the medium of malt, than that in the case of glucose or sugar?—Yes, undoubtedly, but I do not think that it is a danger which can be disregarded.

657. No; I was really asking as a question of comparison. For instance, taking the question of adding sugar as priming to beer when finished, in that case if there was any mischief it would be irremediable? It is applied to the article of consumption when it is approaching completion?—Of course, in that case there is no diminution whatever in the arsenic which is put in. Even allowing for the yeast picking up a certain amount there would not be very much diminution if a large quantity was added in the first instance before fermentation. I think there is some reason for supposing that if you put a very large amount of arsenic into the liquor to be fermented, the yeast fails to exercise its power of picking it out, to a certain extent at any rate. The yeast gets degenerated.

658. And your report tends to show, does it not, that there are two remedies, at all events, in regard to the question of malt, one of which if carefully applied would give something like security to the consumer, that is to say, the process of screening and cleaning the malt, on the one hand, and the process you have alluded to with reference to the abstraction of some of the poison by the yeast?—One cannot consider the abstraction of the poison by yeast at all, because I think that everyone would be agreed there should be no arsenic whatever upon malt before it goes into the mash tun. As to the methods by which the malt is to be freed from arsenic, it is true I have seen an apparatus at four breweries, but I cannot profess to lay down the precise manner in which the malt is to be freed from arsenic. It may be freed by not allowing the fumes to pass up through the malt, and very probably it may also be freed by cleaning processes.

659. Of course, when you refer to the desirability of eliminating all the possibility of arsenic from beer materials, you would agree that in this process, as in many other processes where you have to supply food or drink, great care is requisite; it is a question of care on the part of those who are responsible for carrying out the manufacture?—Yes, I think there ought to be some security that no materials are used which contain arsenic.

660. You examined, I see, a good many portions of this malt dust?—Yes. We took a large number of samples about the 1st January of this year.

661. Have you examined since the outbreak, when special attention was called to this poisoning, any beer which you have ascertained has been brewed purely from malt and hops?—Yes. The beers numbered 38 and 39 are brewed entirely from malt and hops, but these were both from breweries which had formerly used arsenical sugars, and it is impossible to be quite certain that some of it may not have adhered to the vats.

662. From not cleaning the vessels properly, or perhaps from a dirty copper, that had held these other substances?—Yes.

663. You cannot say to the Commission that you have examined any beer which you are satisfied in your own mind had been brewed from malt and hops without any possible contamination such as you suggest?—No, I cannot. I have no doubt whatever that beer brewed in that manner with malt that was not sufficiently clean would contain arsenic.

664. But is not that purely a statement that if there is arsenic in the malt it would be possibly conveyed to the beer unless properly cleaned? You have not tested a sample of beer which you are satisfied had been brewed solely from malt and hops?—Yes, except in so far as some of the arsenic may have adhered from former contamination.

665. With that reservation?—With that reservation.

666. I asked this question of Dr. Tattersall: "You state clearly in your report that if beer had been brewed from malt and hops alone no serious danger from poison with arsenic could have occurred." His reply was: "That is my distinct opinion." I further asked him: "You also say that under no circumstances could beer brewed from malt and hops alone contain more than one-two hundredth grain per gallon—that is, provided certain things are done"—of course, meaning that the malt was properly cleaned. Have not you referred once or twice to the fact of one-twenty-fifth of a grain of arsenic being discovered in malt?—Yes. Malt and hops are not always properly cleaned. *Mr. J. Niven.* 1 Mar. 1901.

667. I think you have referred in your evidence once or twice to the fact of one-twenty-fifth of a grain of arsenic being present?—Supposing the malt were turned into beer, and no arsenic had been abstracted on the way, there would be one-twenty-fifth of a grain per gallon in the beer.

668. Providing no steps had been taken in the interim to clean the malt and abstract the arsenic?—Providing that the malt had not been cleaned in the meantime. All malt is not sufficiently cleaned.

669. And this estimate you make was taken from malt, not from malt dust?—Taken from the malt, as it comes from the maltings before it has been touched by the brewers. I may say that I show on page 40 in the case of two samples the results of the operations of the brewer upon malt. On the second operation you will see that although the arsenic was apparently diminished it was not reduced below the limit of something like one-twenty-fifth of a grain per gallon, perhaps actually less.

670. You examined a great quantity of this malt dust, did you not?—Yes; we took a large number of samples of the dust—that is the soft dust. I might explain one form of the apparatus. The grain shoots down into a circular screen, which consists of two or three portions with different sized meshes. In the first part of the screen as it revolves, the malt culms are either broken off or brushed off, and fall through the meshes of the screen. Then the grain passes on to a second part where it receives a little brushing, but it makes really no material difference. Finally, the grain passes through, going to one of the rollers, and passes on until the coarser grains go through the meshes of the third portion of the circular screen, which is revolving, and from these last two portions a quantity of soft dust is thrown off. In a good form of apparatus that dust is carried off by means of fans, or to a less extent by extraction tubes, but if there is no proper apparatus it will fall down and mix with grain going on to the mash tun, and that does occasionally happen. The dust that has been examined is the soft dust which is given off in the subsequent part of the process in the revolving screen, not that passing through with the culms. Malt dust.

671. If this process has the result of taking the poison out of the malt, I presume on examination you would find it in the dust?—There is an indication that a certain amount has been taken out, but in some cases, unfortunately, it is returned.

672. But is it not a fact that you examined a great deal of this dust which was the result of more than one brewing?—Yes, this dust was deposited for a long period. It shows the operations of the brewery for a very considerable time.

673. Supposing the dust you collected and in which you found this poison represents ten maltings, you would have to divide the result by ten to represent the poison for any one malting?—No.

674. I only want to know by what process you got at it?—Perhaps the dust collects over six or seven weeks, and supposing the malt were all the same malt, then there would be simply so much dust collected after each process, which would all contain the same amount of arsenic. Supposing you could collect the dust of one day it would just contain as much arsenic as the dust of 100 days proportional to the total amount. There would be no accumulation of arsenic.

675. I see in your *précis* of evidence you say, "It is not certain however that a slow process of poisoning might not result from the amount of arsenic found to be present in malt"; is that your opinion?—That is my opinion.

676. You conclude this document with several suggestions as to what should be done to secure the public from this poison. You allude in No. 5 to the desirability of amending the Food and Drugs Act so as to insure that in case of any deleterious contamination occurring in beer or stout it may be possible to trace the source of the contamination, and so secure the destruction of the deleterious article. Have you anything to say upon that?—The Sanitary Committee of the City of Manchester were of opinion that further legislation is necessary for the protection of the public, and I thought it well under those circumstances to consult with the Town Clerk. Suggested amendment of F. and D. Acts.

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The Deputy Town Clerk, Mr. Hudson, who acts in these matters, was of opinion that in that particular the Food and Drugs Act should be amended. We have, of course, no power at present to pass from the retail dealer to the brewery, and that entails not merely a failure in the operations of the Food and Drugs Act, but it prohibits us from being able under the Public Health Acts to seize beer which is grossly contaminated with arsenic, and have it destroyed. Therefore, I am in entire agreement with this recommendation.

Power required to deal with contaminated beer at the brewery.

677. That is to say, if you seize upon a sample of beer and find it to contain arsenic, you desire power to secure the destruction of the whole of that batch of beer of which it was a part?—There is no means of getting at the batch. It is obvious you cannot go under the Public Health Acts into the brewery and seize beer at random; because it might be entirely different beer from that used by the retailer. The only way in which you could do it would be by having power to follow up the beer taken from the retailer, examine it, and finding that it was similarly contaminated, proceed to its destruction. Otherwise you have no power to proceed to the destruction of the contaminated article.

Class of persons attacked.

678. (*Sir William Church.*) In estimating the number of persons who have been affected, you told us that you sent out a paper of questions to 358 medical practitioners. Does that 358 represent all the registered medical practitioners in Manchester?—Yes.

679. The whole of them?—Yes.

680. I suppose many of them practice chiefly among what one might call the poorer classes of the population, and keep open dispensaries?—I do not think I follow your question.

681. I mean keep dispensaries to which the public can go by paying a very small fee, and obtain advice and medicine?—A man in very good practice indeed may have a dispensary of that kind as a public official. There is a body which deals with the establishment of such dispensaries and governs them, and who have powers of appointing medical officers to them, and these medical officers very often have a good practice outside the dispensary practice.

682. I did not mean officers attached to a public dispensary, but rather those who keep what I might call an open shop, where they dispense both advice and medicine at a low rate?—Of that kind of practitioner there are a few, I should say four or five. I may say of one of those practitioners whom I know, that his judgment may be fairly relied upon.

683. I only ask, because I thought a large number of those who were only slightly affected might in the first instance apply to such dispensaries?—I think that a number of people would go to those practitioners.

684. Did you get answers from practitioners who had that sort of practice?—Yes, from four or five of them.

685. I understood you to say that there were only four or five in Manchester?—No, four or five answers from practitioners doing that kind of practice.

686. But there would be a much larger number doing that sort of practice in Manchester?—Yes; but I do not know the number.

687. Would one be right in considering that the larger number of those who were likely to see the slight cases in the first instance would be some of those who did not communicate with you?—I think so, if it were for nothing else, for the reason that they have a very large number of cases, and have not very much time.

Earliest symptoms observed.

688. You told us some of the distinctions between arsenical poisoning and alcoholic neuritis, and I think I understood you to say that this outbreak of supposed arsenical poisoning was remarkable from the absence of the ordinary symptoms of arsenical poisoning, such as vomiting, diarrhœa, and lachrymation?—In the cases seen in the public institutions, and in his answer to the circular which I sent out, Dr. Brooke was good enough to take some trouble in stating that in the large number of skin cases he saw that was also a noticeable feature that they had not running at the eyes or sickness in the first instance. That a good deal of sickness was caused I feel sure. Many of the practitioners who answered perceived the onset of sickness and running at the eyes.

689. I asked you because the other day it was told us in evidence that a certain number of persons had ceased drinking beer, because it made them so ill?—I was told by a brewer that that was so, that he had heard that a good many people had stopped drinking because they were taken sick, and I have heard the same thing from other quarters.

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690. (*Chairman.*) Was that before the alarm had reached the medical practitioners?—Yes.

691. (*Sir William Church.*) So that the absence of the ordinary symptoms of sickness and diarrhœa, and what we call catarrhal sickness, in the pigmented cases, were rather calculated to put medical men off the suspicion of arsenic?—As far as it goes, undoubtedly.

Affection of the skin.

692. You mentioned the rashes, but you did not tell us at all what sort of rashes they were. There are certain rashes which are more or less known to be associated with arsenical poisoning?—The rashes have been extremely various, and my own experience is somewhat limited in that matter. But the eruptions which I myself have seen have been inflammatory lumps with bullæ on the top, erythematous eruptions, and eruptions more or less resembling psoriasis, while the same person exhibited the different types of eruptions. In one case I have seen distinct pemphigus and herpes zoster has been reported to me by a number of practitioners who answered my circular, and a surgeon at the Infirmary states that he had seen about a dozen cases of herpes zoster amongst his cases.

693. That would be rather secondary to the nerves when it takes the form of herpes zoster?—Herpes zoster I suppose is a nervous eruption, but the erythematous rashes would, I presume, be at a very early stage of the illness, because a number of these were certainly present without peripheral neuritis. I have myself seen a few cases in which there was no peripheral neuritis corresponding to these rashes.

694. Of bullæ?—Yes, or very distinctly erythematous. In fact in one case a man was sent down to me by a practitioner covered with plaques, of a bright red, somewhat scaly looking, eruption over the whole of his trunk. That was the kind of case that was absolutely distinctive. One has to take the indications of the dermatologist in this matter as to what the rashes meant.

Statistics of Manchester before [illegible].

695. Have you any suggestion to offer why 1898 should have been a year in which alcoholism and its results appears to have been so markedly less than in the years immediately preceding or the years following. You will see the number of deaths in 1898 are only 48, which is much smaller than in the years immediately preceding or following?—I do not know the explanation of that.

696. Is there an increase in peripheral neuritis?—Yes, but not a sufficient increase to cover the decrease of deaths from alcoholism.

697. Looking at the gastritis numbers there is again a very great difference. In 1899 you will see it is only 11, and one would have expected that if arsenic had been playing a part in 1899 and 1900 gastritis would have been figuring higher than it does?—If arsenic in large amounts due to arsenical sugars had been playing a part; but I do not know that one would draw the same conclusions with regard to the amounts which might have been derived from malt for instance. Very possibly these deaths from peripheral neuritis represent a slower and less acute process than the deaths occurring in 1900, so that it might be quite compatible, with an increase in arsenical poisoning, to have a smaller number of deaths from alcoholism and an increased number of deaths from peripheral neuritis. That is assuming that there was a certain amount of arsenic in the sugar also.

698. I think you used the term that you thought the yeast might degenerate. Have you any knowledge from the breweries that the yeast has not developed in the wort?—I was informed by one brewer that his yeast had gone dead; that it had degenerated.

699. (*Chairman.*) It had ceased to be effective as ferment?—Yes; it declined to rise properly, and had been visibly affected.

700. (*Sir William Church.*) And have they had to get fresh wort into the brewery instead of going on with the old?—I presume they did, but I cannot say.

701. (*Professor Thorpe.*) Are we to gather from you that you think the epidemic, if we may so call it, is practically at an end?—I think so.

702. And you know of no fresh cases coming in?—No; not which one could reasonably ascribe to the recent outbreak. Fresh deaths occur.

Niven. 703. You mean if there are any cases coming under observation they are to be attributed to the pre-existing conditions?—Yes, or are part of a previous chronic poisoning.

of city 704. I was rather struck in reading your report submitted to your authority with the fact that you yourself had to improvise a laboratory to overtake the work of testing. Would you kindly explain why you are not in a position to call upon the City Analyst to help you in this enquiry?—This is a very special kind of enquiry, and one with regard to which one desires to have personal knowledge.

705. But I understand you had to ask the assistance of a gentleman, Mr. Morton Rowe, to help you?—Yes.

706. You yourself were not able to overtake the work and had to ask the assistance of this gentleman?—Yes.

707. Is not the City Analyst as well as yourself the servant of the Sanitary Authority?—Yes.

708. Why could you not count upon the action of the City Analyst? Was he approached with a view to assisting you in this enquiry?—The City Analyst has, of course, conducted the analysis of beers, which we give in this report. That part of the enquiry he has carried out. I did not approach him with regard to the investigation of other matters.

709. But it strikes me as rather singular that, not only in Manchester, but also in Salford, neither of the sanitary officers was assisted by, or able to count upon the assistance of, the official analyst of the respective corporations. Dr. Tattersall explained to us that he had to go to Professor Delépine at Owens College, and you had to invite assistance from some member I presume of your own staff?—Yes, of the sanitary staff.

710. Therefore, you got no official help apparently in the investigation of this matter from the accredited official chemist; is that so?—That is so.

711. With a view to assisting us in the enquiry which may have to be made in similar cases, may I ask you what that points to? Is there any imperfection in the conditions of tenure of appointment, or what?—No. The Manchester City Analyst did not in the first place find arsenic in the beers which were submitted to him.

712. Was it a matter of public notoriety that even before you were engaged in it arsenic had been found in beers?—No.

713. Was not Dr. Reynolds the earliest discoverer?—Yes; but Dr. Reynolds' discovery had not been announced publicly. The samples which were submitted to the City Analyst were submitted on the 21st November—that is to say, two days before any mention of this occurrence was made in the public Press.

714. Broadly speaking, do you think, from what has taken place during this particular period of stress and strain, that it is desirable that something should be done on the part of local authorities to bring together the two officials, one as analyst and the other responsible for the public health, into more immediate and intimate relation?—That is a very difficult question to answer. I think that in matters requiring special skill, or very exact and careful investigation involving a great consumption of time, it might be an advantage if large towns had some consulting body such as an Institute of Public Health to refer to for assistance.

715. Is the City Analyst at Manchester engaged in private practice as an analyst?—Yes.

716. (*Chairman.*) A private chemical practice as a chemical consultant?—Yes.

717. (*Professor Thorpe.*) Is he limited in the amount of analytical work he has to do in return for the salary he is paid?—I think not. I do not remember the exact terms, but it is so much for each sample after a certain amount. The sum diminishes as the number of samples increases.

718. So far as you know, there is nothing in the conditions of his appointment which would have precluded you from asking his assistance in the chemical matters connected with this inquiry?—No.

719. You examined, I think you told us, other glucoses than the one in which you traced arsenic—glucoses other than Bostock glucose?—Yes, a large number—all that we could obtain from the breweries.

720. From the breweries?—Yes, from the breweries of the city.

721. Did you examine any other glucoses than those which were found in the breweries?—Yes, I examined as I have mentioned, two glucoses from sweet factories, and one from a jam factory. *Mr. J. Niven.* 1 Mar. 1901.

722. And in no other sample did you find any appreciable quantity of arsenic than in Bostock's manufacture?—In none.

723. I gather therefore you clearly wish the Commission to believe that the arsenic is solely to be attributed to Bostock's invert and glucose?—Assuming that no other arsenical glucoses were in use besides those which were submitted to us, that would be so. That of course I cannot answer for.

724. You say in your *précis* that the highest amount ascertained in the beer was about half a grain per gallon?—Yes. Quantity of arsenic in implicated beer.

725. "But all the samples examined quantitatively were taken after the Sanitary Committee had issued a warning to publicans," on certain dates which you give, "by means of the daily Press"?—Yes.

726. What is the precise significance of the "but" there? You say: "The highest amount ascertained was about half a grain per gallon, but all the samples examined quantitatively were taken after the Sanitary Committee had issued a warning to publicans"?—Perhaps the word is a little loosely used, but I imagine I had in my mind that the amount of arsenic in a great many of these beers is small, and that as these beers were specially selected on account of the illness of patients and on account of the number of cases occurring in special districts, one might have, under other circumstances, expected to find a larger amount of arsenic, especially taking into consideration the great amount which had been found elsewhere.

727. You do not wish to imply that in any case the amount of arsenic originally present had been diluted down by the addition of other beer?—No.

728. You do not think that has occurred?—No, I do not suggest that; in fact, it did not occur to me.

729. You have no reason to believe that it has occurred in actual practice?—I have not thought of it before. It has not occurred to my mind before.

730. I gather that you are clearly of opinion that the whole of the mischief is attributable to arsenic?—Yes.

731. Other suggestions as to what it may be due have no doubt been brought to your knowledge?—The arsenic found is amply sufficient to account for it, to begin with, and I do not know that any proof has been adduced that other matters mentioned could have produced this amount of poisoning.

732. Can you inform the Commission whether the publicans did take advantage of the warning that was issued by the sanitary authority; did they take steps to send back the beer or destroy the beer?—The beer was for the most part rapidly destroyed, although whether that has to be put down to the action of the publicans or to the action of the brewers I cannot say. I presume that the brewers were much more active than the publicans. Action by brewers and publicans

733. (*Sir William Hart-Dyke.*) They instructed the publicans probably. They would strike at the root of it?—Yes, in the great number of instances.

734. If they were frightened at what was going on they would strike at the root of the difficulty and appeal to the publicans to destroy the beer?—There is no doubt the brewers exerted themselves to get rid of the arsenicated beer as far as they could.

735. (*Professor Thorpe.*) You wish the Commission to understand that the Manchester brewers at all events did all that was in their power to cause the beer incriminated to be withdrawn from consumption?—Without wishing to make myself answerable for individuals, as a body I have no doubt they did do so.

736. Why do you make that qualification?—Simply as a matter of caution: I have no particular brewer or brewery in my mind, but one does not wish to take a general responsibility of that kind without putting in a qualification.

737. Did you attend the inquest which was recently held in Manchester?—I was present for a short time at the inquest, but I did not attend the whole course of it.

738. You said a short time ago that you had been informed by a brewer that the yeast had degenerated in the presence of an undue quantity of arsenic, that the degeneration of the yeast was in your view attributable to the quantity of arsenic?—It occurred during the time Affinity of yeast for arsenic.

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that this sugar was used and it was quite clear that it was associated in his mind with the use of the sugar, but I have no proof of course that it was due to the arsenic.

739. But if it were the case, would that disprove the supposition, to put it, as the Chairman stated, that yeast was an arsenic eater?—If the yeast degenerated in the presence of arsenic that would presumably indicate that arsenic was not necessary for the building up of the yeast?—No one would maintain that it is necessary for the building up of the yeast. On the contrary, I should think it would be quite as likely or more likely to break down of a surfeit of arsenic than from any other reason.

740. It was, in fact, over-fed, you mean?—More likely, in fact.

P. H. Act could not be used to deal with contaminated beer at the brewery.

741. The assistant Town Clerk, I suppose, is a lawyer?—Certainly, a distinguished lawyer.

742. And it was in his legal capacity he advised your authority that under the Public Health Act they had no power to follow up this incriminated beer on the brewery?—That is evidently his opinion from this recommendation. I presume also that the advice was given since the beer was not followed up.

743. Do you yourself draw any distinction between beer and any other article of food which under the Public Health Act you could destroy because it was deleterious, say rotten fruit?—I do not; I do not know whether such a discrimination could be made, but I do not make any such discrimination.

744. What are the circumstances in a brewery which would elimininate it from the general operation of the law?—None that I know of. But you have, of course, to examine and inspect. In fact, so far as I can read the Public Health Acts, I do not think they ever contemplated an occurrence of this nature or are applicable to them. The Medical Officer of Health or the Inspector of Nuisances has to examine and inspect, and has to carry off the material to be condemned by a Justice of the Peace, and altogether it is perfectly obvious that the machinery of the Public Health Acts is not, without modification, applicable to such a case as this.

745. (*Sir William Church.*) Is there not a very great difference between this case and that of fruit and meat, where, if you followed that up, you or your substitute would be able to say by an inspection whether it was fit for use or not, whereas you cannot do that in the case of beer?—I think it is manifest that is what the sections in the Public Health Act do contemplate, that it is obvious and easily ascertained faults in the materials to be condemned which allow you to bring them into operation. Moreover, you have to carry the material before the Justice of the Peace to be condemned. You cannot carry off a cask of beer.

746. (*Professor Thorpe.*) A sample would be sufficient. A man who condemns three or four cwts. of fruit does not bring the whole fruit into the police court?—No, the Justice of the Peace might go to the brewery, but I do not think the sections of the Public Health Act contemplate an occurrence of this kind.

747. But supposing it were the fact that that particular lot of beer was set aside in the brewery and the brewer was perfectly willing to indicate that all that beer was arsenicated, what is to prevent you, if you have the necessary power of entry, to order him to destroy that beer?—Nothing. In that case it would come under the operations of the Act.

748. (*Dr. Whitelegge.*) And the brewer would be the principal witness against himself?—Yes.

749. (*Professor Thorpe.*) Have you still in your possession any sample of Bostock's glucose and the acid which they use?—Yes, I think so.

750. Would you be in the position to put that at the disposal of the Commission if you are requested?—I think so. I cannot say how much remains.

751. Perhaps you will kindly take care it is preserved?—Yes, what is remaining shall be preserved.

Powers of M.O.H. with regard to poison in food,

752. (*Dr. Whitelegge.*) Is there within your knowledge any officer whose official duty it is, under official instructions, to make himself acquainted with and study the dangers to public health arising from the presence of poison in food—is it part of your own official duty?—It is not specified.

753. Not under any public instructions?—No.

754. Is it the duty of the Public Analyst?—No.

755. Is it the duty of any other officer of the local authority as a formulated duty?—Not as a formulated duty.

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756. You regard it informally as one of the duties properly falling on you, to watch in a general way?—Yes; I suppose I should do. I may say, however, that I have not administered the Sale of Food and Drugs Act in Manchester.

757. Who does administer it?—The Superintendent of the Sanitary Department.

758. Acting under your advice or instructions?—He would, of course, take my advice in any matter which might occur. I am responsible to that extent.

759. But in ordinary circumstances you take no part in the administration, or direction of the administration of the Sale of Food and Drugs Act in Manchester?—Not in the ordinary current administration.

760. In this particular instance, that of the arsenical poison, did the initiative come from you or the chief inspector?—The initiative came from me naturally, because I was informed of the occurrences of cases of arsenical poisoning; that is to say, I consulted with the Sanitary Superintendent, who at once sent out and procured samples from the tied houses belonging to the breweries which I indicated.

761. You laid down the scheme of sampling?—Yes, in the first instance.

762. Have you received any official instructions as to the methods of sampling, as to the articles that ought to be taken for the purposes of the Food and Drugs Act, from the Local Government Board or from any Government department?—The Local Government Board sent down an instruction, I think, to take samples of jams and sweets and some other matters, which was carried out.

763. (*Chairman.*) In connection with this alarm?—Yes.

764. (*Dr. Whitelegge.*) But apart from that no official intimation has reached you as Medical Officer of Health of the points upon which it is necessary to keep a watch in this connection?—I do not remember any memorandum bearing upon that subject.

765. Do you receive any information as to what is done in other parts of the kingdom?—You are aware, of course, that there is an annual report published?—I am aware of that.

766. Do you receive it?—I do not think so.

767. Not officially?—Not officially.

768. So that you have no official information on the subject?—No.

769. Is there a common understanding as to the number of samples to be taken from the local authority, or the kind of samples?—I think not. I may say that it is understood that a very large number of samples of certain foods should be taken in Manchester—it is well understood a very large number of samples of milk should be taken.

670. An understanding on the part of the City Council?—Yes.

771. But again not arising out of any official statement or instruction?—Not that I am aware of.

772. Is it usual in other towns for the Medical Officer of Health to have charge of this work?—In some towns.

773. In such a town, when the Medical Officer of Health first takes charge, to whom must he look for guidance as to the proper steps to be adopted?—I presume to these annual reports.

774. Which he does not receive?—Which are available.

775. There is nothing in the form of instructions to a newly-appointed officer?—No. Still an officer entrusted with these duties would of course take steps to inform himself as to what was being done in other places as a preliminary to his own work.

776. What staff is available at Manchester for the purposes of these Acts?—There are two inspectors under the Sale of Food and Drugs Acts.

777. For that purpose alone?—Yes.

778. And, as I understand, they are not under your control?—Not immediately under my control. Mr. Rook, the Sanitary Superintendent, put them under my control in the earlier stages of this matter; that was a matter of friendly understanding between us, while after November 28th I was instructed by the Chairman of the Sanitary Committee to take what steps I considered necessary in the matter of analysis.

779. As regards the Public Analyst, his duties, I understand, are to examine samples submitted officially

to him for the purpose by the public authority or by private persons?—Yes.

780. It is no part of his official duty under his appointment as public analyst to advise the Corporation?—I should think not.

781. That has never been stated as part of his official duty to your knowledge?—Not that I know of.

782. (*Chairman.*) Does he make a formal report at stated times?—He is required by Statute to make a detailed report once a quarter, and I have here a copy of such a report.

783. (*Dr. Whitelegge.*) When samples are sent to the public analyst, are they coupled with instructions what to look for?—Not generally, I imagine. In particular instances, where he might carry out special work more or less of the nature of investigation, he would be naturally told what to look for.

784. In the absence of special instructions, would you expect the analyst to look not only for adulterations and abstractions and substitutions, but also for harmful components?—No, certainly not. I do not think it is possible to expect that the public analyst will make an exhaustive examination of every sample submitted to him.

785. Would you expect a public analyst in the case of samples of beer to look for arsenic?—I should now.

786. Not in past years?—I think not; I think it would be too much to expect that he would be aware of the presence of arsenic in glucose.

787. Then in future years, would you expect the analyst to look for arsenic in beer?—Yes.

788. In all samples of beer?—Yes.

789. And to determine it quantitatively?—If present, and if possible.

790. You would extend that I suppose to other food substances in which harmful ingredients had been found from time to time?—Poisonous ingredients, yes; after a due warning of those ingredients and materials had been conveyed to the public analyst.

791. By whom?—By the sanitary authority.

792. But in the case of beer, do you think a special warning to the sanitary authority is needful?—Not now.

793. Is any warning within your knowledge given to a public analyst by anybody else but the public authority, or as a matter of public notoriety?—No.

794. He does not receive instructions from the Local Government Board or Government laboratory within your knowledge?—No, not formal instructions.

795. Have you acted in consultation with the analyst as to the samples to be taken?—No.

795. I want to make clear about your powers, as you understand them now under the Sale of Food and Drugs Act and the Public Health Act; and first as regards the retailer. If we assume that the retailer of beer and the brewer and the manufacturer, let us say of sulphuric acid, all have their works within the Manchester district; you have power to take samples from the retailer, to have those samples analysed, and to take proceedings against the retailer, because of adulteration. If he has a warranty from the manufacturer who supplies him—that is the brewer—have you power to take proceedings against the brewer?—I am not certain. I should have to look up the Sale of Food and Drugs Acts.

797. You have no experience at all events in connection with taking procedure under warranty?—I do not remember the sections relating to the warranty, but the working of the warranty sections have been so complicated and unsatisfactory that I would not like to commit myself on any point connected with that without looking them carefully up.

798. Then we will go on to the brewers. As a matter of fact the brewers gave you assistance and information, I understand?—Yes, that is manifest, because one could not have carried out these examinations without such assistance.

799. Assuming that the brewer had not been willing to give the information you required, do you consider that you have power of entry in brewers' premises in any circumstances?—To take samples?

800. For any purpose?—To see if there was a nuisance.

801. Would you have power of entry for the purpose of taking samples?—I understand not.

802. (*Chairman.*) You could not demand samples of the different products?—No; that is the view taken in Manchester that we could not demand samples from the brewer.

803. (*Dr. Whitelegge.*) You cannot tell us the reason why you cannot demand samples?—No, I cannot.

804. Assuming you had no difficulty in obtaining entry and that you succeeded in obtaining samples, then unless in the case Dr. Thorpe mentioned when the brewers themselves volunteered the information that it contained the arsenic, you would not know by inspection that it contained arsenic until after you had removed the sample, sent it to the analyst, and received the analyst's report?—That is so.

805. Then upon that report if you could establish the identity of the sample with some beer still left on the premises you could seize that beer, you think—not under the Sale of Food and Drugs Act, but under the Public Health Act?—Yes, if you can establish the identity.

806. Do you anticipate difficulty in establishing identity?—Yes. You would have to sample every barrel in the place; it would not do merely to examine one sample of beer; you would have to examine the whole series.

807. Having proceeded to seize this sample you would have to call in the Justice of the Peace to get it condemned?—That would be so.

808. You know of no case of the kind?—May I say, further, that the Justice of the Peace would have himself to come to a conclusion as to whether the beer was unfit for food, and his conclusions might not agree.

809. His conclusions might be legitimately based on the evidence you placed before him?—Yes. He would have the same evidence.

810. To go a stage further, would you consider your position the same in the case of a chemical manufacturer who supplied the brewer who supplied the retailer. If you found a chemical manufacturer making sulphuric acid which contained arsenic, would you have any power at all with regard to him?—I think not.

811. Would you under any circumstances have power to seize the sulphuric acid containing arsenic?—I think not. You would have to establish that it was going to be used for food, and I think the difficulties in doing so would be insurmountable.

812. I did not quite follow one of your answers to Dr. Thorpe's questions, but I want to ask you for my own information. Do you consider that there is probably any arsenical beer remaining in Manchester at the present time, whether waiting for rebate duty, or for any other purpose; or, on the other hand, has it been all destroyed?—I should like to be quite clear about that question. By arsenical beer, do you mean seriously contaminated beer?

813. Yes, I do?—I should be inclined to think that there was none, but it would be difficult to be certain of that.

814. You think there is now no beer brewed from the incriminated sugar refinings?—I do not think so; but of course one cannot be sure of that.

Arsenic in malt dust.

815. On page 42 of this report, dealing with malt, you mention one particular brewery. "In No. 15, the quantity of arsenic was conspicuously large, a brewery which had not used Bostock's sugar." Can you tell us anything about the beer from that brewery?—No, I cannot.

816. You cannot identify it with any of the figures you have given us elsewhere?—No. That is not amongst any of the beers which have contained arsenic, and I cannot be certain whether a sample has been obtained from No. 15. I am quite sure it is not one of the beers that have contained arsenic, and I am not sure that samples have been taken.

817. (*Chairman.*) In No. 15 I see you say that the quantity of arsenic was conspicuously large, a brewery which had not used Bostock's sugar?—Yes; but on the other hand, there was no great quantity of arsenic, no excessive quantity of arsenic in the yeast. Now, it is manifest that that means there was no great amount of arsenic in the beer.

818. What do you mean by the quantity being conspicuously large?—That was in the malt dust.

819. Not in the beer?—No; that simply shows that very arsenical malts had been used, but it gives no indication as to how much arsenic may have been taken out of these malts by the screening and other prepara-

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tions at the brewery. That you must infer from the state of the yeast. The yeast at the same brewery simply gives crystals—that is to say, contains no large amount, and one may reasonably infer that the amount present in the beer would have been such that it would not have been detected by our tests.

820. Does not "exceedingly fine large crystals" means a large quantity of arsenic?—It means there has been a large amount originally in the malt which may have been taken out in the screening operations.

821. Was the beer of that brewery examined?—The beer was not examined, but the yeast was examined. The yeast is given on the same line, No. 15, three from the bottom in the series.

822. But when so large a quantity of arsenic was found in the dust, was it not considered desirable to test the beer?—The beer was not tested, but it is manifest from the condition of the yeast that the beer would not contain a large amount of arsenic; indeed, it would contain a very small amount.

823. The smallness of the quantity of arsenic in the yeast was considered sufficient to guarantee the safeness of the beer?—I do not consider any beer quite safe that contains arsenic at all, but it is quite sufficient to guarantee that the amount in the beer would be very small.

824. (*Dr. Whitelegge.*) Is it within your knowledge that there has been an increased use of Bostock sugar in breweries in Manchester since about 1896?—I have no facts bearing upon that.

825. Dr. Tattersall gave us evidence on that?—Dr. Tattersall made that investigation.

Future action availble to M.O.H.

826. As the outcome of recent experience, what future routine do you propose to adopt in Manchester in the matter of safeguarding the public health against the risk of arsenical poisoning in beer? To begin with, what steps would you take to ascertain future cases of peripheral neuritis or other mischief that could be attributed to arsenic?—I think it is necessary to take a considerable number of samples of beer for chemical examination, and to examine them for the presence of arsenic, and to prosecute should the beer be found to contain arsenic.

827. You would rely in the first instance on the Sale of Food and Drugs Act, and take samples and examine them specially for arsenic?—Yes, I should.

828. Are you taking steps to inform yourself of any future cases of arsenical poisoning; have you adopted any procedure?—No formal procedure.

829. Do you propose to adopt any?—I do not know that any formal procedure is practicable except to visit the public institutions and get the resident physicians to show one any cases which they may have. You cannot expect private practitioners to inform you of these matters.

Obtaining returns from Hospitals.

830. But you would obtain returns from the public institutions?—It is perhaps desirable to obtain returns, but I think it is desirable to see cases personally.

831. That is rather more onerous, is it not?—Yes.

832. At any rate, you propose to keep in touch with the public institutions with special reference to this particular point?—Yes. And I think the suggestion you offer as to obtaining returns is one I should be inclined to follow out.

833. And that would be equally necessary in other towns as well as Manchester?—Yes, no doubt.

834. (*Professor Thorpe.*) Are these public institutions in any way under the control of the municipal authority?—No.

835. Absolutely dissociated from it?—Yes.

836. Have they not even a visiting power?—No; still they are expected to give information on matters of this kind to the public health officer, especially if requested.

837. (*Dr. Whitelegge.*) Practicall you are in touch with the Royal Infirmary and the other public institutions?—Yes.

838. And obtain information from them?—Yes.

839. Do the figures you have given us include the cases at the Skin Hospital and other special hospitals?—They do. It is, of course, always better to have these matters put on the formal basis.

840. To have an automatic machinery for the purpose?—Yes.

841. (*Sir William Church.*) As medical officer of health, are not the returns of the cases in the Poor Law Infirmary at Crumpsall, for instance, submitted to you?—The numbers.

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842. Only the numbers, not the diseases?—No, only the numbers. I heard not a word of this occurrence until Dr. Reynolds informed me on the 29th November, not a whisper of anything of the kind being in progress.

843. (*Dr. Whitelegge.*) Have you any reason to think that the mortality returns are understated; is there any tendency, for example, to make out the death certificate for some symptom rather than the cause in this case?—Doubtless in a number of the cases other phenomena of the disease would be put down in the death register, such as heart disease, bronchitis, and that kind of thing.

844. Addison's disease, possibly?—Yes, in cases of pigmentation, possibly Addison's disease.

845. But you have no knowledge of that having been done?—I have none. I have not searched the register for that. I should think it was much more likely they would be put down as heart disease or bronchitis.

846. Do you attach any importance to influenza as bearing on the recent prevalence of cases of arsenical poisoning?—No.

847. Nor to other zymotic influences?—No.

848. Dr. Reynolds gave us particulars of some cases, and I think you referred to them in your report, of tending to establish the time of development of the disease?—The period during which it was necessary that the poison should act.

Shortes of deve ment of sympto of poiso

849. The minimum interval?—I have obtained only two cases in which it was possible definitely to obtain the interval. It is page 13 of my report:—"Case A.—A woman was discharged from Crumpsall Workhouse five weeks ago (Report, Dec. 7th, 1900). At that time she was not suffering from alcoholism or arsenical poisoning. After her discharge she took beer very freely for a week or so, after which she had only two or three gills per day. She first noticed something wrong a fortnight after discharge, the first symptoms being numbness of the feet, followed by tingling. About this time she had vomiting and diarrhœa. She has now well-marked pigmentation. (Brewery from which beer obtained C, also B.) Here the poisonous effect was produced at most in a fortnight, and probably more nearly in a week. Case B.—A man, age 42, was treated for rheumatism in Ancoats Hospital for three months. He was discharged from Ancoats Hospital six weeks ago (Report dated Dec. 8th, 1900), and two weeks after discharge his eyes began to water very freely, and his feet and hands began to burn. (Admitted into Chorlton Union Hospital on November 24th, 1900.) Present condition—symptoms of peripheral neuritis well marked. Excessive sweating of the hands and feet, which are erythematous and scaly. This man drank four or five pints of beer daily from one source. (Brewery C, also B.) Precisely the same remarks apply here as in the previous case."

850. Can you tell me about Case A; how long she had been in Crumpsall?—I cannot.

851. You are satisfied that as a minimum a fortnight is sufficient?—These cases appeared to show that.

852. Are you prepared to accept anything as a negligible minimum of arsenic in beer as the result of your experience?—No.

853. Would you go so far as to say that there must not be even a trace of arsenic?—Yes, I should.

854. Then you would not agree with the recommendation, which probably was a provisional recommendation, made by the expert Committee?—No. I think if you allow a certain amount determinable by chemical tests you are always in danger of getting more.

No ar should allow beer.

855. And therefore you would insist upon the entire absence of arsenic?—Yes.

856. (*Professor Thorpe.*) Entire absence of arsenic can only be determined by a chemical test?—That is so, and you must take some simple and well-known chemical test which will show the presence of a very small amount, and yet fail to detect an infinitesimal amount.

857. That itself indicates a minimum?—No doubt.

858. It all depends on the character of the test you apply as to where you draw the line?—Yes, by the finest available test.

859. Your recommendation comes to the definition of a test?—That is so; ultimately you cannot avoid that.

860. (*Dr. Whitelegge.*) But if I understand you rightly you would fix upon the most delicate test, and insist there

should not be enough arsenic to give a positive result with that?—That is my opinion.

861. Would you consider arsenic, in any quantity whatever, in beer a deleterious substance?—I cannot say. I should regard it as a contamination.

862. But you would not go so far as to say that it was necessarily a deleterious contamination?—No one could scientifically do so.

863. There are certain recommendations at the end of your report. I want to ask you with regard to the last of those. You say, "It is desirable that the Food and Drugs Acts should be amended so as to ensure that, in case of any deleterious contamination occurring in beer or stout, it may be possible to trace the source of the contamination, and so to ensure the destruction of the deleterious article." Could you tell us what sort of machinery you think of for giving effect to that?—No, I am not prepared to.

864. You have not thought out the details?—No. That is the joint recommendation of Mr. Hudson and myself carrying out the wishes of the Sanitary Committee in regard to legislation.

865. The earlier recommendations on the list amount practically to a stipulation that the manufacturer of food and drink shall always, in ordering his chemicals, say they are for the manufacture of food and drink, and that the chemical manufacturer shall supply them to him avowedly for that purpose?—Yes, with a statement securely attached to each consignment of that fact as well as on the invoice.

866. I think it came out in evidence that the invoice used by Messrs. Bostock had some such heading?—No, I think not. I think they call themselves sugar refiners.

867. Would not that imply making food substance? It did not succeed in conveying that impression, but would it not bear such an interpretation?—My suggestion is that it should be clearly stated on the order that the chemical was to be used in the manufacture of food, using the word "food" or using the word "drink."

868. You would have it written, and not merely printed as part of the heading?—Whatever would be most likely to be most effective.

869. Do you anticipate any difficulty in defining "chemicals"?—I did not put this forward as legally perfect or as technically perfect. I think, perhaps, it might be an advantage if the chemicals which were most in use in the manufacture of food stuffs were specifically mentioned.

870. (*Professor Thorpe.*) Would baking powder be a food or a chemical?—Baking powder is clearly a chemical, so is acetic acid used in pickling. I may say I have examined six samples of pickling vinegars but found no arsenic in them.

871. Take pickling vinegar, you consider that as a chemical?—I do.

872. Would you require this procedure in the case of a private purchaser, or only in the case of a purchaser who was going to submit the articles to manufacture on a commercial scale?—I was only contemplating persons intending to manufacture it on a commercial scale.

873. But the same sort of danger would apply to the private purchaser?—Yes, but you may make impracticable laws.

874. Would not there be a difficulty again; take the case of sulphuric acid supplied to Messrs. Bostock; the vessels would have to be labelled as you suggest, and they would be returned with the labels on, would not they, and would not there be a danger of the labelling becoming a mere form?—Yes, and the vessels being filled up without fresh labels.

875. Did not something of that kind come out in evidence in the inquest?—It came out in evidence that the red mark was retained on the consignment although the sulphuric acid was not pure; a mark which was intended to signify purity was still retained.

876. (*Chairman.*) And impure acid put in it?—Yes.

877. Would not that be a very serious matter?—In my opinion it is a serious thing yes. In that case possibly it might be necessary to destroy the label, to put in a qualification that the label should be destroyed after each consignment had been used.

878. (*Dr. Whitelegge.*) There would be some difficulty, would there not, in enforcing a system of that kind by inspection?—Yes. I think it is clearly necessary that these special chemical manufactures should be visited under the Home Office, and should be submitted to distinct regulations.

879. (*Professor Thorpe.*) Why the Home Office as against the Local Government Board?—Because the Home Office usually deals with matters of that description as I understand, not for any other reason.

880. (*Dr. Whitelegge.*) By matters of that kind you mean matters relating to manufacture?—Yes.

881. But not matters connected with public health?—No, that falls to the Local Government Board.

Medicinal dose of arsenic

882. (*Sir William Hart-Dyke.*) Will you kindly inform the Commission what amount of arsenic, medicinally speaking, it is considered safe to give a patient?—10 drops of liquor arsenicalis is often given to children, and sometimes produces poisonous symptoms.

883. What would that be equivalent to in grains?—Three-tenths of a grain per diem, I think.

884. (*Sir William Church.*) It is a very large dose. That is the amount that you give in twenty-four hours?—Yes. This is a paper by a practitioner in Manchester which you may have seen, who used it very largely in the treatment of St. Vitus's dance, and a certain number of the cases were affected with symptoms of peripheral neuritis.

885. (*Sir William Hart-Dyke.*) It is taken in cases of neuralgia as a pain-killer, is it not?—I do not know. I have not had much experience of it.

886. I asked you because I have taken it myself largely?—The usual medicinal dose is from 2 to 8 drops, that is to say one-fiftieth to one-twelfth of a grain.

887. (*Chairman.*) Drops of Fowler's solution?—Yes, which would be about one-fiftieth to one-twelfth of a grain.

888. I have been prescribed one drop with each meal, that is four times a day. That would be a small dose?—Yes, that is a small dose. Some people suffer from small doses. They get sick with very small doses of Fowler's solution.

THIRD DAY.

AT WESTMINSTER PALACE HOTEL.

Wednesday, 6th March, 1901.

PRESENT:

The Right Hon. LORD KELVIN (in the Chair).

The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Mr. COSMO BONSOR.
Professor THORPE.
Dr. WHITELEGGE.

Dr. BUCHANAN *Secretary.*

Dr. EDWARD WILLIAM HOPE, called; and Examined.

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889. (*Chairman.*) You are Professor of Public Health at the Victoria University and Medical Officer of Health for the City and Port of Liverpool?—Yes.

Epidemic in Liverpool, extent.

890. Have you investigated or have you means of knowing the amount of sickness and death in Liverpool due to the recent epidemic?—Yes, I have. I was one of the members of a small sub-committee appointed by the Liverpool Medical Institution to investigate the extent of the poisoning epidemic in Liverpool, and that sub-committee tabulated 100 cases of poisoning which admitted of very easy verification. They were all of them cases which had been treated in public institutions, and consequently were open to the observation of any medical man who was interested. But besides these, a very large number of cases came under notice of illness attributed to arsenic, but in these cases they did not admit of the same verification, and I have not therefore tabulated them. I may say that out of the total number eight of the cases proved fatal, and in four of these inquests were held. Perhaps I may as well say here that arsenic was found in the viscera of some of these, and there was no doubt whatever as to the cause of death.

891. Was there any evidence as to how the arsenic had got into their systems?—The evidence showed conclusively that beer was the medium by which the arsenic was conveyed.

Inquiries by M.O.H.

892. Has any attempt been made by you to find out the number of such cases in private practice? You spoke, I think, of other cases besides these 100?—Yes. I made inquiries of medical men; in fact, medical men volunteered information, and the actual number of people poisoned I believe to be largely in excess of 100. At the same time, in many of these cases there were perhaps elements of doubt, and I thought it best for the purposes of this inquiry to confine myself to those cases about which there could be no possible doubt.

893. Those 100 cases were all treated by public institutions?—Yes.

894. What were those institutions?—Chiefly the Mill Road Infirmary, and a few at the Brownlow Hill Workhouse. Both institutions are in Liverpool.

895. Were both those institutions for very poor classes of people, and for the artisan class?—They are Poor Law institutions.

896. So that the inmates of those hospitals were persons receiving Poor Law relief?—They were persons who in time of sickness would naturally apply to those institutions. It does not follow that prior to their sickness they were in receipt of Poor Law relief, but when sickness came that was the most ready way of getting relief.

897. Persons of the artisan class, labourers, and workmen, would apply to such hospitals?—Yes.

898. For themselves or their wives and children?—Yes.

899. (*Dr. Whitelegge.*) Have you any figures showing the sex of these 100 cases?—I have not them with me except the fatal cases.

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Dates of commence ment and terminatio

900. What are the approximate dates of the commencement and the end of the outbreak in Liverpool, as far as you can judge?—The probable commencement appears to have been about June or July, and the removal of the cause of the poisoning was about the 27th or 28th of November, perhaps subsequent days. Cases of poisoning have occurred since that date, but the actual poisoning happened prior to it, although people sought relief afterwards.

901. Are new cases still coming in?—I do not think there have been any new ones in the last fortnight or so, but all new cases coming to the hospital have been poisoned prior to the 27th or 28th of November.

902. Do you think the danger is over for the present?—Yes.

Due to arsenic in beer.

903. (*Professor Thorpe.*) You say you are clear in your mind that the exceptional sickness and death are due to no other cause than arsenic?—That to arsenic in beer.

Arsenic in beer before 1900.

904. (*Chairman.*) In respect to arsenic in beer, have you any reason to think that there has been arsenic in beer previously, and that detrimental effects have resulted from it previous to this outbreak?—Yes, it would appear so, although there are no analytical reports to support that belief. It is by inference that I base the opinion that there was arsenic in beer some months prior to the 26th of November, when it was definitely ascertained to be there.

905. In previous years?—No, last year I mean.

906. In previous years have you reason to think that there might have been something of the same deleterious influence, if not to the same extent?—It is possible, but I have no evidence to show that that was the case.

907. The forms of illness, peripheral neuritis and alcoholic neuritis, were shown before this outbreak?—Yes, we are very familiar with alcoholic neuritis in Liverpool.

908. And do you think that in some cases previously to the year 1900 the illness may have been really due to arsenic, and not merely to alcohol?—Yes, it is quite possible that it may have been, but we have no evidence to show that that is the case.

909. Do you know anything of beer having been suspected and tested for arsenic before the recent outbreak?—I know it is our routine practice as a health authority to cause analyses of beer as well as every other article of food to be made, but we have never had any report from the analysts to show that there was arsenic in beer until November of last year.

910. Was the analysis previous to last year of such a character that arsenic would be detected by it?—That I am not in a position to say. All that I can say is that the samples were certified to be genuine samples, and I cannot think a sample would be certified to be genuine if it contained a deadly poison such as arsenic.

911. But if the analysis was not directed to the test of that poison it might have been there and not discovered?—If the analysis were not directed to that poison, of course, it might have been; but the analyst will, of course, give you his own information.

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912. Do you know whether illness has arisen from the use of chocolate or syrups or jams or marmalade or preserved sweets?—No, there is no reason whatever to suppose that arsenic was in any kind of jam or sweets or confectionery at any time.

913. Or preserved fruit, or syrup and golden syrup?—Or preserved fruit. No, nor in fruit wines. As a matter of fact, a large number of these samples were specifically tested for arsenic in November, December, and January, and none of them contained any trace of arsenic.

914. I believe those confections and syrups contained glucose largely?—Yes.

915. The syrup, I suppose, was almost entirely glucose?—No, golden syrup is not glucose. It is cane sugar—pure sugar.

916. Did treacle or substitutes for treacle contain arsenic?—They might contain it, but there was no arsenic found in any of the large number of samples examined.

917. Treacle was examined, I suppose?—Yes.

918. And the treacle, of course, came originally from cane-sugar as a by-product or refuse, but more recently it has been, I believe, manufactured from glucose?—Yes, I believe so.

919. But in no case has arsenic been discovered in any of these substitutes, has it?—No, none whatever.

920. It has been a routine practice, you told us, to take samples of all kinds under the Food and Drugs Act?—Yes.

921. Was bread tested?—Yes, large numbers of samples of bread, flour, and other things.

922. And if there was some arsenic in the yeast used in the bread that would show in the bread?—If there had been arsenic in the bread it would have been detected.

923. It would have been detected by the tests that were made?—Yes. The analysts have, I know, made specific tests for arsenic in almost every kind of food stuff.

924. Before the present inquiry?—No, coincidently with it; at the same time that the arsenic was found in the beer.

925. Not very many samples of beer were taken for analysis before the recent occurrences?—No, very few. Beer has been so uniformly reported to be genuine that the numbers of samples taken of it were allowed to fall down to a very small number. Beer seldom analysed by Public Analyst before 1900.

926. The test for genuineness of beer at that time would not have shown arsenic?—I presume not.

927. (*Sir William Church.*) Could you inform us at all whether the number of cases of peripheral neuritis, or neuritis of all kinds, in Liverpool was greater than the average found in other large towns, or is it the same?—I could not say. I have no comparative figures, but I have a table showing the deaths for the last two years from those causes and from alcoholism. Mortality statistics in Liverpool.

928. You do not know how that compares with London or Newcastle or other large towns?—No, I do not.

The Witness handed in the following table:—

CITY OF LIVERPOOL.

1900.

Deaths from	1st Quarter.		2nd Quarter.		3rd Quarter.		4th Quarter.		Year.		Total.
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
Excessive Drinking	17	12	14	11	12	17	11	12	54	52	106
Natural Causes accelerated by excessive drinking.	15	7	22	12	15	17	19	13	71	49	120
Alcoholism	1	–	6	4	4	2	3	1	14	7	21
Neuritis	–	–	–	–	–	–	–	–	–	–	–
Peripheral Neuritis	–	–	–	2	–	1	–	4	–	7	7
Multiple Neuritis	1	1	–	–	–	–	–	1	1	2	3
Alcoholism accelerated by some irritant poisoning.	–	–	–	–	–	–	–	1	–	1	1
Alcoholic Neuritis	–	*(1)	–	(1)	–	†(1)	–	†(1)	–	(4)	(4)
	34	20	42	29	31	37	33	32	140	118	258

Those figures marked ( ) were included under Excessive Drinking or Alcoholism.

* Inquest. † Mill Road Infirmary.

1899.

Deaths from	1st Quarter.		2nd Quarter.		3rd Quarter.		4th Quarter.		Year.		Total.
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
Excessive Drinking	11	8	14	8	12	6	13	8	50	30	80
Natural Causes accelerated by excessive drinking.	21	13	18	6	20	8	20	12	79	39	118
Alcoholism	4	3	1	4	6	4	2	3	13	14	27
Neuritis	–	–	–	–	–	–	1	–	1	–	1
Peripheral Neuritis	1	2	–	2	1	3	–	4	2	11	13
Multiple Neuritis	1	–	–	–	1	–	–	–	2	–	2
Alcoholic Neuritis	–	*(2)	–	*(1)	–	–	–	*(1)	–	(4)	(4)
	38	26	33	20	40	21	36	27	147	94	241

Those figures marked ( ) were included under excessive drinking or alcoholism.

* 2 Mill Road Infirmary, 2 Brownlow Hill Workhouse } Not Inquests.

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929. (*Chairman.*) Do you know whether peripheral neuritis was reported either, for example, in Newcastle or in London?—No, I believe it was, but I have not gone at all into the question.

930. Can you give us some information with regard to the Mill Road Infirmary and the consumption of beer in Liverpool?—At the Mill Road Infirmary there was an increase in the number of cases of what we believed to be alcoholic neuritis in or about September, and the medical superintendent of the institution drew my attention to that circumstance. It was chiefly amongst women, and it happened at a time when there was evidence to show that money distributed to Reservists' families and others was not being well applied, and we attributed the increase of alcoholic neuritis to an increase in the drinking habits of certain sections of the community, who obtained money from charitable people. There is evidence to show that there was an increase about September or October, and that attention was directed to it; but it was not until November 26th that there was actual evidence as to arsenical poisoning. At that time the sanitary authority of Liverpool felt that the position was one of exceptional gravity on account of the very large quantity of beer consumed in Liverpool and of the large number of houses at which the beer is sold. I believe that the amount of beer consumed in Liverpool approximates to three-quarters of a million gallons per week.

Consumption of beer in Liverpool

931. What is the population of Liverpool?—668,000.

932. Roughly, three quarters of a million?—Yes.

933. So that that would be about a gallon a week per head, man, woman, and child?—Yes, approximately.

934. That seems an enormous consumption?—It is an enormous consumption. There are 2,223 houses within the city where beer is sold. It was obvious to the sanitary committee and its advisers that if beer was to be the medium, or might be the medium, of arsenical poisoning, that very prompt measures were necessary to deal with what might prove to be a catastrophe. If beer were poisoned, the results would be almost as lamentable as if water were poisoned. The circumstances needed the promptest possible measures to deal with them.

Analysis of Beer for arsenic before 1900.

935. (*Dr. Whitelegge.*) I want to be quite clear about the conclusion you draw from the analysts' certificates dated prior to the suspicion of arsenic. The samples in October and before October were reported as genuine, were they not?—Yes.

936. You drew the conclusion from that that there was nothing harmful in them?—Certainly.

937. If the question of arsenic had arisen would you have concluded from those certificates that there was no trace of arsenic?—I should have concluded that there was no trace of arsenic, or that the attention of the analyst had not been given to the possibility of such a thing, and that he might perhaps not have examined it for arsenic.

938. Do you rely upon the analyst to examine for what is necessary?—Absolutely.

939. You give him no instructions on sending him samples?—No. I need hardly say that in the face of this emergency circumstances were very altered, and he needed no instructions to examine for arsenic.

940. (*Chairman.*) It was not usual formerly to test for arsenic at all, was it?—I cannot say whether these samples were tested for arsenic or not. I do not know. I have not asked the analyst. As a matter of fact, I do not think they were; but I have not asked him.

Glucose an adulterant of golden syrup.

941. (*Dr. Whitelegge.*) You told us that glucose was found in treacle and other articles that were examined?—Probably.

942. What action do you take in such a case?—We would deal with an article which was sold as a cane sugar and which contained glucose as an adulteration under the Food and Drugs Act.

943. And if it was sold as treacle?—That is another matter.

944. Then no line of action has been defined?—It has not been defined, but golden syrup is understood to be a product of pure sugar.

945. (*Chairman.*) Cane sugar?—Cane sugar or beet sugar.

946. (*Professor Thorpe.*) With reference to that answer, you are quite familiar with the fact that golden syrup, although presumably derived from cane sugar or beet sugar is occasionally mixed with glucose?—No, I am not aware of that except illegally. It may be so illegally.

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947. You in Liverpool probably have as many prosecutions for the admixture of glucose in so-called golden syrup as anywhere?—I dare say. At the same time, we have only had a very few.

948. I think I may say, as a referee under the Food and Drugs Act, that it is notorious that you in Liverpool have taken an active part in putting down the illicit admixture of glucose with cane sugar molasses, and selling that as golden syrup?—Yes, most likely. I daresay we are more active than most other places.

949. Yet you tell the Commission that even in such samples of golden syrup as have been examined, and which at least presumably might contain glucose, there has been no evidence of arsenic found?—No evidence at all, although they have been specifically examined for arsenic.

950. Are you in a position to tell the Commission what would be the origin of the glucose which would be in golden syrup? Would it be a native, or imported glucose?—I could not give you that information.

Consump of beer i Liverpo

951. (*Sir William Church.*) I should like to know how the figures of the consumption of beer are arrived at in Liverpool?—It is a calculation which I made myself upon evidence given before the Licensing Bench as to the amount sold at individual houses, and I believe it to be well within the limit.

952. You got the returns from the different licensed houses of their weekly sales?—No, that is not quite so. The evidence was given in the case of a number, and upon that, taking those as a fair criterion and as a fair average, I made my calculation of the rest, and that calculation has not been questioned by those who might question it if it were inaccurate. It is merely an estimate.

953. It has not been checked in any way by the deliveries from the breweries, which I suppose could be ascertained?—Yes, I daresay it could be checked.

954. It seems such an enormous amount?—It does; it seems almost incredible. I could hardly think it would reach such a figure, but the most careful consideration leads me to that conclusion.

955. (*Chairman.*) It seems to indicate two or three or four gallons a week being consumed by heavy drinkers?—Yes, quite that, or even more.

956. (*Dr. Whitelegge.*) Can you give any reason for the observed cases being so much more numerous in the Mill Road Infirmary?—The only explanation I can give is that at the south end of the town a large number of beer shops—public-houses—are in the hands of a brewer whose beer was not contaminated. At the same time this same brewer has houses elsewhere, but I am inclined to think that that is the explanation. I can think of no other explanation. Then you must remember also that the Mill Road Infirmary perhaps serves a larger and more populous district than either of the others. Those two causes may explain it perhaps.

Arsenic Beer sin the epi

957. (*Professor Thorpe.*) You give in your *précis* the names of the brewers whose beers were examined during October, 1900?—Yes.

958. Have any of the products of those breweries been found to contain arsenic subsequently?—Yes.

959. Will you tell us which?—The beer of seven firms was examined then.

960. You are prepared to give us the names of brewers whose beers were found to be arsenicated after October, 1900. You have given us the names of certain brewers, samples of whose beer were examined in 1900. Now I wish to ask you if some of them were subsequently found to be arsenicated?—Yes.

961-2. Will you tell us the names of those brewers?—They are the first, second, and sixth on the list.

963. (*Chairman.*) That is after October?—Yes, on or about the 26th or 27th November.

964. But they might have been arsenicated in October, as the tests made in October were not decisive as against arsenic?—Yes.

965. (*Professor Thorpe.*) There is nothing to lead you to suppose there had been any change in their procedure?—No.

966. The presumption therefore is that their beers in October would have contained arsenic?—It is quite likely, although it would be well to bear in mind that, in taking a number of samples of beer brewed by the same brewer, some of them were arsenical, and some

were not, so that it is a mere inference as to what the condition was in October.

967. These brewers would be using malt substitutes prior to October, would they not?—Yes; I should think there is no doubt about that, but I do not know it of my own knowledge.

968. Were they customers of Bostock's to your knowledge?—Yes.

969. Were they customers of Bostock's prior to October, to your knowledge?—I should think they were; I think there is no doubt of it, but I have not been told so. They have been for some time customers of Bostock's, and I think I may safely say that they were customers of Bostock's before October.

970. Of course, the analyst in taking these samples would have nothing to guide him as to the origin of the beer?—The analyst receives his samples from my own officers, and he has nothing to guide him as to the source from which the beer comes. It is given him in the usual way, with a number on it. The sample is sealed up with a number attached, and he knows it by the number, and reports upon it by the number.

971. Of course, there is nothing in the appearance of the beer which would lead him to infer that it had been made from a malt substitute, or that it was not wholly the product of malt and hops?—I should not think so.

972. (*Chairman.*) Did your officer get the samples from the breweries or from the publicans?—From both sources.

973. (*Professor Thorpe.*) But not prior to October?—No; the October samples were all taken from shops under the provisions of the Food and Drugs Act.

974. (*Chairman.*) Will you explain what you as a medical officer of health are allowed to do under the Public Health Act?—It appeared to me to be the first and imperative duty to stop the sale of the arsenical beer in the promptest possible manner. Had we proceeded under the Sale of Food and Drugs Act, we should have taken a few samples, ten or a dozen, it may be; they would have been sent to the analyst for presumably a quantitative analysis, and on receipt of his report it would have been necessary to give notice to the person who sold the beer that in fourteen days an information laid against him would be heard. The delays which would necessarily have been involved by such a procedure might have resulted in the consumption of arsenical beer for another fortnight or so, and if that consumption had taken place the amount of mischief would have gone on and increased during that time. Therefore, it appeared to me that action under the Food and Drugs Act was altogether too slow to deal with an emergency such as that with which we were confronted. At that time we did not know whose beer was contaminated. The brewers themselves did not know; in fact, we were absolutely in the dark as to which of the 2,000 odd public houses were selling poisonous beer, and it was our business to find that out at the quickest possible moment. Therefore, I instructed the inspectors to obtain as large a number of samples as the analyst could deal with, and I requested him to report to me forthwith whether or not there was any arsenic present, irrespective of the quantity. So that, instead of having to wait for a fortnight or more before taking action, we were able to take action within a few hours. The action we took was to cause a meeting of the Brewers' Association to be called together, and to intimate to them as soon as we knew ourselves that their beer was either contaminated or suspected. The brewers in the meantime—many of them—had employed their own analysts, and in some cases received information as to the character of their beer before our own analysts were able to give it to them, and as a consequence, within a very few days a considerable quantity of beer was poured into the sewers. The amount of which I received official information was 267,522 gallons.

975. What does the Public Health Act allow you to do?—Another course open, and which occurred to me to put into application, was the Public Health Act, which would enable us to seize the contaminated beer. But there were two difficulties in the way of that application, one being that the beer was not offered for sale, and another that we had no evidence as to which of the many barrels were contaminated and which were not, and until we had some such information we could not put that Act into force. The promptness of action on the part of the brewers, who themselves were extremely anxious, of course, to get rid of this poisonous stuff, resulted in ridding the city in a very few days of the main bulk, at all events, of the arsenical beer. I have prepared some tables, which indicate the date of the purchase of the sample, the date at which the informal report was received from the analyst, the date at which the official report was received, and the earliest date upon which proceedings could have been taken under the Food and Drugs Act, had we elected to adopt the course of procedure only under the Food and Drugs Act. I should like to call your attention to one instance—they are all alike—but I should like to emphasise the point by referring to one. On the 27th November six samples were taken. On the following morning, the 28th November, the informal report was given to me by the analyst as to which of them contained arsenic. I received his official certificate on the 6th December, and it would not have been possible under the Food and Drugs Act to have taken action before the 21st December. So that by the course we adopted we dealt with the arsenical beer in a few hours, within a day, but under the Food and Drugs Act, 24 days would have elapsed before we could have taken any case before a magistrate.

976. Then this early action was done by the aid of the brewers and by the brewers?—It was done partly by the brewers; they were perfectly willing to take this course, and to empty away any suspected beer. If they had not been willing we should of course have taken proceedings against them 24 days afterwards.

977. Under the Food and Drugs Act?—Yes. We should have taken proceedings against the person who sold the beer, not the brewer; against the licensee—some old woman in a back street, it may be, who had absolutely no means of knowing the quality of the stuff she was selling.

Actions under F. and D. Acts must be taken against retailer.

978. With regard to this 268,000 gallons that were destroyed, were they destroyed chiefly in the breweries, or did the brewers recall the beer from the publicans to whom they had sold it?—It was chiefly in the breweries, but they did recall some from the publicans, and they did empty away out of the publicans' cellars quantities of beer without taking it back to the breweries at all.

Destruction of Beer.

979. (*Dr. Whitelegge.*) It was all destroyed by the brewers and not by the publican?—It was all destroyed by the brewers. I should like to make that point plain, that many of these public houses are the property of the brewers. They are tied houses, and sell only that particular brewer's beer.

980. (*Chairman.*) Is the beer in these public houses the property of the brewers?—Yes, in some cases, but not in all.

981. And the publicans are merely the selling agents of the brewers?—In some cases; perhaps in the majority of cases they are merely the selling agents.

982. (*Professor Thorpe.*) Does this 267,522 gallons include what was destroyed on publicans' premises?—Yes, it includes all that I have knowledge of—all that I could get reliable information of.

983. The brewers themselves furnished you with that information?—Yes; but in some cases I have independent evidence that it was quite correct information.

984. The greater portion, no doubt, would be what was destroyed in the breweries?—Yes, in the breweries. Perhaps it is only right to say that it was not all contaminated; it was all suspected, but at least in one instance I could quote, samples of it which were taken before it was turned out were subsequently found to be free from arsenic. What I wish to show is that the brewers were willing to spread their precautions as widely as they could, that there was no hanging back on their part in ridding themselves of this beer.

985. Can you say the same equally of the publicans?—In one or two cases the publicans kept the beer on their premises with a view to recovering its value, I understand. Without saying anything about it, they kept it there—a most improper proceeding.

Contaminated beer kept on publican's premises.

986. In the case of the publican, surely it being offered for sale, or presumably offered for sale, you could seize and take proceedings to punish the publican?—The inspector received information of it in this particular case, and he forthwith went to the place and had

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it all emptied out. Possibly it would have been a wiser thing if he had seized it and taken proceedings to punish the publican who had kept it there, but it was not offered for sale, and it was in a part of the premises which prevented it being offered for sale, I believe.

987. Then under what Act did you proceed—under the Public Health Act?—We would have proceeded under the Public Health Act in that case to seize the beer and to have it dealt with by a magistrate as unfit for human food.

988. (*Chairman.*) Are you referring to the Cornbrook Brewery Company?—Yes, that was one.

989. Were there others?—There was one other.

990. What is the name of the other?—It was in the Netherfield Road. I do not remember the name. It was a house owned by a private publican, and not a house which was restricted to the sale of one particular brewer's beer.

991. And some of the beer in this publican's house was contaminated?—Yes.

992. And some not?—And some not. Instead of emptying away what he had reason to think was contaminated he had set it aside in order to recover the value from the brewer without any intention of selling it. That was his statement.

993. (*Professor Thorpe.*) Was it a Liverpool brewer from whom he got it?—Yes.

994. Had there been any difficulty, or did he apprehend any difficulty, in getting back the value from the brewer?—I do not think so. I never heard such a suggestion.

995. (*Chairman.*) Was that improper if he took absolutely rigorous measures to avoid its being sold to the public?—I would not trust him. As an official I should say it was an improper thing to have it on the premises at all.

996. (*Professor Thorpe.*) Was the brewer with whom he was dealing one of those brewers who voluntarily destroyed their beer?—Yes.

997. So that he would have had no difficulty?—He would have had no difficulty at all if he had gone about it in the right way. I suppose some dispute arose, and this man held back, and did not have the beer turned out.

998. (*Chairman.*) Did he apply to the brewers?—The brewers informed my officer of it, and the officer went forthwith and had it all turned out.

999. (*Sir William Church.*) With regard to these 260,000 odd gallons of beer that were destroyed, do you know how many firms that affected?—Twelve firms, I believe.

1000. (*Chairman.*) You have the names of all those firms?—Yes.

1001. (*Sir William Church.*) Are any of those twelve among the seven breweries whose names we have had, where the beer was tested in October?—Yes, the first one and the second one; only these two.

1002. I notice that these two firms are local firms; that is so, is it not?—They are not essentially Liverpool firms. I think they are Salford and Manchester firms principally, but they have large establishments in Liverpool also.

1003. Have you any idea of the proportion of beer which is furnished by what I may call the local breweries, and those which are not local, such as Salt's, Guinness's, and Bass, which you have mentioned in your table?—No; I cannot give you the relative amounts or proportions of beer sold by these firms, but I think on the whole it may be said that the local firms sell the most.

1004. I suppose the last one on the list is one of the largest purveyors of beer in Liverpool?—Yes.

1005. Therefore the incriminated beers, the beers in which arsenic was found, were all what might be called of local firms?—They were local in the sense that their headquarters may be either in Liverpool, Manchester, Salford, or Chester.

1006. (*Dr. Whitelegge.*) The beer of the sixth firm on the list, I think you told us, was found to contain arsenic?—Yes.

1007. Was not that firm one of those who destroyed their stock?—I believe the analyses showed that they did destroy some, but I have not a return as to the quantity.

1008. You told us that if you had proceeded under the sale of Food and Drugs Act, after a delay of 24 days you would have been able to take action?—Against the persons who sold the beer—the retailer, not against the brewer.

1009. Would that action have had the effect of causing the destruction of the beer or merely the infliction of a penalty—It would merely have inflicted a penalty, and nothing else, upon the retailer, the person who had handed the glass of beer over the counter.

1010. Were all your samples at that time taken from retailers?—At the beginning they were all taken from retailers.

1011. Did you take any samples with the formalities under the Sale of Food and Drugs Act from breweries?—No.

1012. Do you think you have power to do so?—No; I do not think we have power to do so under the Sale of Food and Drugs Act.

1013. (*Professor Thorpe.*) Arising out of that, in case a brewer is made to give this warranty, or chooses to give on demand a written warranty, would you not have power?—I believe so. We might then proceed against the person giving the written warranty; but I never heard of a brewer giving a written warranty in any case.

1014. That is possibly the way now?—Yes; I think it would be a most desirable thing that something of that sort should be done. It is a most important thing.

1015. You are aware, doubtless, that in the case of large milk distributors, middlemen, and even farmers, they are frequently obliged to give warranties?—Yes.

1016. And in case a retailer is brought into the police court, he can plead the existence of his warranty, and then the wholesale man can be made a party to the suit?—Yes; that is frequently done.

1017. There is no real reason why that should not be done in the case of beer, is there?—I hope that will be done in the future. I was intending to refer to that matter later.

1018. (*Dr. Whitelegge.*) But in that case would you rely upon the sample taken from the retailer, or would you take samples from the brewery?—I should like to see the powers extended very considerably, and I propose to make suggestions on those very points, that powers should be given to obtain samples from breweries, and also samples of the materials from which the beer is manufactured.

1019. We will come to that later. I want to make it clear at this stage whether you think, as matters stand, that you have powers to-day to take samples from breweries under the Sale of Food and Drugs Act?—I do not think we have. The sale of Food and Drugs Act essentially implies a sale, but in breweries they do not, or rather they may not, sell anyone a glass of ale.

1020. (*Mr. Cosmo Bonsor.*) Have you power to take samples from any manufacturer of food, not a retailer, under the Food and Drugs Act?—No, not under the Food and Drugs Act, I think.

1021. We will take such foods as those advertised for infants, and so forth; have you any power to go to the manufacturer and take samples?—No.

1022. Only from the retailer?—Only from the retailer.

1023. (*Dr. Whitelegge.*) You have told us that in proceeding under the Public Health Acts in the case of a brewery there would be difficulty of identifying the contaminated beer?—Yes. The difficulty of ascertaining that it is contaminated without the power of first going to get a sample, which we do not possess.

1024. And ordering its retention, I suppose?—Yes.

1025. And coming back in a fortnight?—Yes.

1026. You have no effective power of the kind, I presume?—No.

1027. And in the absence of those powers the Public Health Act does not materially help you in the case of breweries?—It would only help us in this respect, that if we had reasonable ground for suspecting the beer upon a certain brewery had been contaminated with arsenic, we should not hesitate to seize it and have it dealt with by a magistrate, because, as I say,

we were not following out the lines of the Food and Drugs Act, and we should at all events give publicity to the fact that beer suspected or contaminated was there, and we should put some of the onus of the emergency upon the magistrate.

1028. The action you contemplate would be going to the brewery, taking possession of some or all of the beer on suspicion of its containing arsenic, taking it before a magistrate, or bringing the magistrate to the brewery?—Taking it before a magistrate in the usual way.

1029. Would you expect the magistrate to condemn it then and there?—In the meantime we would have had an analytical report upon a sample of it. It would only take a few hours after the seizure.

1030. Has that been done in any case in Liverpool or elsewhere, to your knowledge?—No. I mention it to show that we should have had to have recourse to some roundabout procedure, very difficult of application, had it not been that the brewers acted exactly as any other tradespeople would have acted—as bakers and milk dealers would have acted—and discharged the suspected or contaminated materials.

1031. Is the Public Health Acts Amendment Act of 1890 in force in Liverpool?—Yes.

1032. Do you think that Section 28 of that Act helps you?—That would be the section we should have had to go upon.

1033. You spoke of "analysts" in the plural: is there more than one public analyst in Liverpool?—Yes, we have two chemical analysts and one bacteriological analyst, all under the Sale of Food and Drugs Act.

1034. With different districts?—No; they work together.

1035. Was any beer retained on a large scale by brewers for Excise reasons?—Temporarily, I believe there was.

1036. Have you given us the number of breweries in Liverpool?—There are 60 different beer-selling firms, not 60 breweries.

1037. (*Chairman.*) How do you distinguish "beer-selling firms" from public-houses?—In this way. Many of the public-houses belong to one particular brewer—some hundreds of them. Besides that, there are public-houses, privately owned, at which any person's beer may be sold. There are 60 independent beer-selling bodies—perhaps more—I will put it in that way.

1038. (*Professor Thorpe.*) Do you mean wholesale beer-selling bodies, or retailers?—Wholesale and retail.

1039. (*Mr. Cosmo Bonsor.*) Either brewers themselves or their agents in other parts of the country?—The point is this, that in one house the beer of any manufacturer is sold; I look upon that as one distinct and separate agent. This one agent may himself have a dozen or more houses in which he carries on that same kind of business. Then, on the other hand, there are very large numbers of houses tied to principal brewers, in which no beer except that of the principal brewers is sold, unless by agreement. But we have samples from 60 separate and independent sources, and the table I have submitted relates to those 60 firms.

1040. (*Professor Thorpe.*) I should like to ask you about your power under the sale of Food and Drugs Act. In what sense is the publican not the actual servant of a brewer who has a tied house? Is not the man in the tied house the actual servant of the brewer?—I do not quite know what the legal aspect of the matter would be. But in prosecutions that I have heard or read of the person proceeded against is the actual retailer—the person who actually sold the beer.

1041. But if you go into a shop under the sale of Food and Drugs Acts and buy an article of food which is eventually found to be wrong, you do not proceed against the assistant who sold it?—You do in some cases.

1042. But is not the usual plan to indict the actual owner of the premises?—Yes.

1043. Why should not the brewer be brought under the same category if he is the actual owner of the tied house?—Because the brewer is in the same category as the manufacturer—we will say—of golden syrup, or of a mixture of what is called "French coffee."

1044. But he is both the manufacturer and the seller?—He may be, but not necessarily.

1045. In the case of tied houses is he not, strictly speaking, both the wholesale man and the retailer?—Our legal advisers tell us not. We can only be guided by them.

1045. (*Mr. Cosmo Bonsor.*) The licensed holder of a public-house is the responsible person, is he not?—Yes.

1047. The licensed holder is not the brewer?—That is so.

1048. (*Chairman.*) Have you experienced any difficulty in getting beer analysed?—At the commencement of the arsenical poisoning epidemic we had considerable difficulty, because the various laboratories were so full that we were obliged to limit the investigation and restrict it to determining whether or not there was arsenic present. We found that that was the best way of employing the time of the analyst. The brewers themselves were sending large numbers of samples from all parts of the country, and the various laboratories in Liverpool were quite overtaxed with making analyses of beers. So far as the city analysts were concerned it would not have been possible for them to have examined one-tenth of the number of samples for quantitative analyses which were dealt with in the way I have described. Difficulty in getting beer analysed. Brewers' samples largely analysed.

1049. Was the source of the arsenic traced?—Yes, very speedily. It was traced to glucose and invert sugar, manufactured by Messrs. Bostock. Messrs. Bostock are sugar refiners, in Garston, which is a few miles from the boundary of Liverpool; they are not within the city. Bostock's works outside Liverpool.

1050. Returning to the subject of public analysts, is it customary for public analysts to examine samples in their private capacity?—Yes; I believe there is no restriction. P. Analysts and private samples.

1051. Do they habitually or frequently do so?—Yes; I believe that under the Sale of Food and Drugs Act they may be called upon to do so. Upon the payment of a fee they are required to make an analysis for any person who asks them.

1052. Under the terms of a public analyst's appointment, has public work the first claim upon his time?—I do not know whether the terms of his appointment require it; but as a matter of practice, public work has the first claim upon his time.

1053. We should like to know the total number of samples, and the dates, and so on?—The total number of samples taken from 60 different firms is shown in the accompanying Table. Arsenic or traces of arsenic to a varying extent were found in the beer supplied by 20 of these firms. Results of analysis of Liverpool Beer.

The sequence in time and the proportionate number of samples found by the Public Analysts to be contaminated are as follows:—

—	Number of Samples taken.	Number found contaminated.	Remarks.
1900:			
During October - -	10	0	
From 27th Nov. to 3rd Dec.	76	25	Contaminated to a greater or less extent, some being duplicates.
From 4th to 10th Dec. -	135	23	Contaminated, nearly all slightly, some being duplicates.
From 11th to 17th Dec.	65	4	Contaminated to the extent of a minute trace.
From 18th to 24th Dec.	11	0	
From 25th to 31st Dec.	4	0	
1901:			
From 1st to 7th Jan. -	10	0	
From 8th to 14th Jan. -	22	0	
From 15th to 21st Jan.	38	0	
From 22nd to 28th Jan.	18	0	
From 29th Jan. to 4th Feb.	10	2	
From 5th to 11th Feb. -	10	0	
From 12th to 18th Feb.	4	0	
From 19th to 25th Feb.	4	0	

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The extent of contamination of these samples is shewn in the following additional table :—

PARTICULARS relating to implicated Firms.

Firm of Brewers. Identifying Numbers.	Number of Samples taken.	Number found contaminated.	Remarks.
2	12	1	Doubtful.
4	5	1	Doubtful.
7	20	2	1 — trace. 1 — doubtful.
11	11	3	1 — 1½ grains. 1 small quantity. 1 — 1-14th of a grain.
13	14	3	A quantity of arsenic.
14	14	8	1 — ⅔ of a grain. 3 — ½ of a grain. 1 1-7th of a grain. 1 1-9th of a grain. 2 a small quantity.
20	10	3	2 — a quantity of arsenic. 1 1-14th of a grain.
22	3	2	A trace.
24	20	3	1 1-12th of a grain. 1 1-15th of a grain. 1 a trace.
28	6	1	Doubtful; trace.
31	13	1	⅛ of a grain.
36	13	4	1 — 1½ grains. 3 — a quantity of arsenic.
38	14	3	1 — 1-13th of a grain. 1 — 1-12th of a grain. 1 — a quantity.
39	10	3	1 — 1½ grains. 2 — a quantity of arsenic.
45	4	1	1½ grains.
47	15	6	A trace.
48	9	1	A quantity of arsenic.
51	33	1	Doubtful.
53	2	1	A trace.
60	12	1	A trace.

1054. (*Dr. Whitelegge.*) Are the firms brewers?—Not necessarily. Out of 237 samples taken from the 20 firms, 52 were found to contain arsenic. Of the remaining 40 firms 178 samples were taken, and all of them were found to be entirely free from contamination.

1055. Do you understand that to mean that they had no trace of arsenic whatever?—Yes.

1056. Could you tell us the terms of the analyst's certificate? Were these samples pronounced to be "genuine," or was it expressly stated that they contained no arsenic?—In some cases it was expressly stated that they contained no arsenic; in other cases they were stated to be "genuine," and in others "genuine" or "passable."

1057. Were they all taken for the special purposes of your inquiry?—Yes.

1058. And were they all taken within the knowledge of the analyst in order to ascertain the presence of arsenic?—Yes.

1059. (*Chairman.*) I see in the table, in some cases "a quantity of arsenic," and in other cases the quantity is stated; does "quantity of arsenic" mean more than a trace?—Yes. The analyst gave me his definitions as well as the maximum quantities. The largest amount of arsenic was 1½ grains to the gallon. That amount, I think, was found in four samples. Four samples contained 1½ grains to the gallon, 2 contained ⅔ of a grain, 3 contained ½ a grain; 18 contained "a small quantity," which the analyst defines from 1-10th to 1-12th of a grain; 25 contained "a mere trace"—something under 1-50th of a grain; and 363 were certified as "genuine."

1060. (*Sir William Church.*) I see there is a heading "doubtful" in your table?—Yes. In 25 samples there was "a mere trace," amongst which may be included some "doubtful" ones. The remainder, 363, are certified "genuine."

1061. (*Chairman.*) With regard to "a mere trace" of arsenic does that mean anything up to 1-12th of a grain?—No; much less than that, so the analyst informs me.

1062. (*Dr. Whitelegge.*) But what becomes of the intermediate figures? If more than 1-50th and less than 1-12th, in which group would it go?—This would range from 1-15th or 1-20th or 1-100th of a grain, to a quantity as to which it would be very doubtful whether there was any or not.

1063. (*Professor Thorpe.*) Would any of these be included in the 25 samples?—Yes.

1064. (*Chairman.*) I see many entries, "a quantity of arsenic"; does that mean a quantity less than 1-12th of a grain? In one case I see "a small quantity," and in a large number of cases I see "a quantity"; might that be a large quantity?—A "large quantity" would be something like ½ or ⅔ of a grain. The report would have been made before any quantitative estimate had been made.

1065. Would not the analyst explain the meaning of the entry, "quantity of arsenic," as distinguished from the other entries?—Yes; he gives a definition of those expressions, but I cannot put my hand upon it at the moment.

1066. (*Professor Thorpe.*) I suppose some of the phrases, such as "a quantity," "a small quantity," and "a large quantity" would have reference to a preliminary statement which the analyst made to you in order to enable you to act promptly?—Yes, that is so. The maximum quantities are stated in the tables in actual amounts, so that, however he describes it, you would know that there were not more than four samples with 1½ grains per gallon, nor more than two with ⅔ of a grain, nor more than three with ½ a grain. The other quantities, however they are described, are below those. As a matter of administrative importance, I should like to mention that these bad samples were among the earliest that were taken. The Table I have already put in indicates the numbers taken during the first week.

1067. (*Chairman.*) I presume we shall have the analyst before us, who will explain these entries?—Yes. The only other point I wish to mention is that the worst samples taken were among the earliest, and as days went on we found a gradual disappearance of this arsenical beer.

1068. That was after the alarm had been given, I presume?—Yes.

1069. (*Sir William Church.*) Can you tell us what time you think elapses between the manufacture of the beer and its delivery to the retail houses?—A very short time, I believe—a week or so. Probably in a week or ten days the brew would be consumed. It is not stored on the premises for any length of time.

1070. So that beer brewed this week would probably be placed at the public-houses for consumption within a fortnight?—I should think so.

1071. (*Chairman.*) We should like to know the names of the brewers to whom these identifying numbers correspond?—I will hand in the whole sixty names, together with the results.

The following Table was handed in :—

BEER.

COMPLETE PARTICULARS relating to FIRMS, Free and Implicated.

No.	Firm.	Number of Samples taken.	Number found contaminated.	Remarks.
1	Allsopp's	9	0	
2	Barker	12	1	Doubtful.
3	Bass	14	0	
4	Bate & Sons	5	1	Doubtful.
5	Beardhills	1	0	
6	Bell, John	2	0	
7	Bent's	20	1	Trace doubtful.
8	Birkenhead Brewery	2	0	

COMPLETE PARTICULARS, &c.—*continued.*

No.	Firm.	Number of Samples taken.	Number found contaminated.	Remarks.
9	Blezard	5	0	
10	Bramley & Sons	9	0	
11	Burton Bell & Co.	11	3	1 = 1½ grains. 1 = small quantity. 1 = 1-14th grain.
12	Burton Brewery Co.	1	0	
13	Cain's	14	3	A quantity of arsenic.
14	Cornbrook's	14	8	1 = ¾ grain. 3 = ½ grain. 1 = 1-7th grain. 1 = 1-96th grain. 2 small quantity.
15	Evershed's	1	0	
16	Findlater's	2	0	
17	Gartside	2	0	
18	Gatehouse	2	0	
19	German Lager Beer Company.	1	0	
20	Glover and Sons	10	3	2 a quantity of arsenic. 1 = 1-14th of a grain.
21	Greenhall, Whitley	9	0	
22	Groves and Withnall	3	2	A trace.
23	Guinness	7	0	
24	Harding and Parrington	20	3	1 = 1-12th of a grain. 1 = 1-15th of a grain. 1 = a trace.
25	Heyes	1	0	
26	Higson's	7	0	
27	Hill's (Burton)	1	0	
28	Houlding's	6	1	Doubtful. Trace.
29	Ind, Coope & Co.	13	0	
30	Jeffreys	1	0	
31	Jones	13	1	¾ of a grain.
32	Joplin	8	0	
33	Kensington Brewery	1	0	
34	Lager Beer Company	2	0	
35	McEwan's	1	0	
36	Montgomery's	13	4	1 = 1½ grains. 3 a quantity of arsenic.
37	Rigby's	10	0	
38	Mellor's	14	3	1 = 1-13th of a grain. 1 = 1-12th of a grain. 1 = a quantity.
39	Robinson's	10	3	1 = 1½ grains. 2 = a quantity of arsenic.
40	Salt & Co.	5	0	
41	Showell's	1	0	
42	Smart's	13	0	
43	Smith, Mumford's	5	0	
44	Smith, Tadcaster	2	0	
45	Tarbuck's	4	1	1½ grains.
46	Tetley's	1	0	
47	Threlfall's	15	6	A trace.
48	Thoroughgood's	9	1	A quantity of arsenic.
49	Tower Brewery Co.	1	0	
50	Trueman's	4	0	
51	Walker's	33	1	Doubtful.
52	Walker's Peter	5	0	
53	Watson, Woodhead	2	1	A trace
54	Webster	1	0	
55	Webster & Atkins	9	0	
56	West Cheshire	2	0	
57	Whitbread	1	0	
58	Whittle Spring's	10	0	
59	Worthington	3	0	
60	Yates	12	1	A trace.

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1072. Can you tell us anything with regard to the arsenic in malt?—Traces of arsenic were found in malt used by Liverpool brewers or destined for their use, but in relatively small quantities as compared with the arsenic in the glucose.

Quantity of arsenic in glucose.

1073. I see among the analyses here 4½ grains to the pound is mentioned. Is that in one sample of glucose?—Yes.

1074. In another case I see 9½ grains of arsenic to a pound of glucose?—Yes, that is Bostock's glucose. The analyst estimates that the first sample would represent from one-third of a grain to one grain of arsenic in a gallon of beer, and presumably the second one would represent double that amount.

1075. (*Dr. Whitelegge.*) Are both these Bostock's sugars?—Yes.

1076. (*Chairman.*) Does that assume that all the arsenic reaches the finished beer?—That assumes the liability to contamination.

1077. (*Professor Thorpe.*) Was that estimate of the amount of arsenic in the glucose deduced from the composition of the beer, or was it a direct determination from the glucose?—A direct determination from the glucose.

Arsenic in malt.

1078. (*Mr. Cosmo Bonsor.*) Were the samples of malt which were analysed taken from brewers or maltsters?—I understand they were taken from maltsters, but the analyst could give you all the details as to that.

1079. (*Chairman.*) Have you any quantitative statement as to arsenic in malt?—No, the traces are very minute.

1080. Have you examined the process of the kilning in the manufacture of malt?—I may say that I am aware that the presence of arsenic is attributed to the coke or coal used in the kilns in drying malt, and that it may be easily removed, so I am informed, with the dust by screening.

1081. Do you think it is safe to have grain coated with arsenic, and then the arsenic brushed off afterwards?—No, I think it is most undesirable.

1082. You are not an expert in malting, and you cannot say whether the process of roasting or whatever it is, could be conducted without exposure to the fumes of the fire?—I should think it is perfectly easy to prepare the malt without arsenical contamination. If it were not so, the presence of arsenic would be more frequent, and from the fact that the arsenic in the malt is relatively infrequent one must see that it is not necessary that it should be there. With proper care and precautions the presence of arsenic can be avoided.

1083. That is a precaution as to the fuel?—Yes; but it is better that it should never be there rather than that it should be removed afterwards.

1084. But you do not know whether the process could not be conducted so as to bring about the same result without exposure at all to the fumes of the fire?—I have only the broad fact that the malt is as a general rule prepared without arsenic, and if it can be avoided in some cases it can be avoided in all.

1085. As it is, it is always exposed, I believe, to the fumes; and the use of proper fuel, not containing arsenic, is the only safeguard at present?—I believe that is so.

No arsenic should be allowed in beer.

1086. What have you to say with regard to the question of a negligible minimum of arsenic in beer?—It has been suggested that in some cases the arsenic present is so minute in quantity that it may be altogether neglected, that it can have no material effect upon the public health, and that its presence is of no consequence. I think myself that is an extremely bad view and a very improper one. In my opinion, there should be no arsenic at all in beer, and it appears to me that there is no necessity why there should be any. It is the exception to find it. If beer in ninety-nine cases out of a hundred can be manufactured so as not to have any trace of arsenic, it should always be so manufactured. I also think that the smallest quantity of arsenic may be productive in certain cases of great mischief to the beer drinker. I think it properly deserves its name as a deadly poison, and that no quantity of it should be allowed in a beverage or in a food.

1087. Then you are of opinion that even a trace of arsenic discovered by chemical test should condemn the food or the beer containing it?—Yes.

1088. (*Sir William Church.*) Have you formed any opinion as to the action of arsenic upon man in very

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small quantities, either in conjunction with alcohol or not, when taken for a long period; do you think it has a cumulative effect?—Yes, I believe it has. This recent epidemic clearly shows that a prolonged use of minute quantities has resulted in maiming, in serious illness, and in death. I think those facts are established by the recent epidemic.

1089. Can you give us your views with regard to the elimination of arsenic from the body?—My views on that matter, I think, would not be better than those of any other medical man.

Greater fatality among women.

1090. I believe in Manchester the cases were more fatal among women than among men?—That has been our experience in Liverpool also.

1091. Have you any explanation of that?—It may be that the men are stronger to start with—that their constitutions are stronger—that they are leading more active lives. I can give no other explanation than that.

1092. You have no view as to the fact except that probably the men lead more active lives, and that, therefore, probably their skins act more freely than in the case of women?—That is the only suggestion that I have by way of explanation—that by the active, laborious lives which the men lead they may have got rid of it. Cases, however, have come to my knowledge in which I have asked the poisoned woman what her husband had to drink, and I was told that he had had exactly the same as she had had, and as much to drink, or even more, and that he had escaped poisoning. It is a very curious thing, but that seems to be so.

1093. Are the proportionate figures between the sexes latterly the same as they were formerly before the poisoning by arsenic was suspected?—No; there is an increase in the number of women poisoned.

1094. But with regard to the alcoholic neuritis, I suppose there were more fatal cases in women than in men?—Formerly there were more cases of men, but latterly there have been more cases of women. Then, of course, there is the fact that Addison's disease, as you know, was assigned as the cause of death in several of these cases, which have since been shown to be arsenical.

1095. That arose from the pigmentation?—Yes. Last year there were seven deaths certified to be due to Addison's disease. Five of them were females. The average of the preceding five years was only two deaths per annum from that disease.

Pigmentation.

1096. Had pigmentation ever been noticed in connection with neuritis before last year?—I think not. I never heard of it being observed.

1097. In your experience you would say that pigmentation was not met with in what used to be termed alcoholic neuritis?—It had never been noticed or mentioned, and I never saw it.

1098. Therefore these cases, quite apart from the other evidence of arsenic, differed from the ordinary cases of alcoholic neuritis or multiple neuritis, in that a large proportion of them were more or less pigmented?—That is so.

1099. In Liverpool was any increase of sickness and diarrhœa noticed before there was a suspicion of poisoning by arsenic?—No, there was absolutely nothing at all to attract attention beyond those cases of neuritis.

1100. Nothing came to your knowledge as Medical Officer of Health?—Nothing at all.

1101. Do you know whether most of those cases did suffer from gastric symptoms at first?—No, I do not. They were under the care of Dr. Raw, who, I believe, will apear before you.

1102. (*Chairman.*) Do you know whether the beer drinkers themselves began to find that beer disagreed with them before the public scare took place?—There was no sickness attributed to beer. If the beer drinkers felt they were getting ill they had no idea what it was that was making them ill.

1103. We have heard that at Manchester and at Salford the beer drinkers began to give up drinking beer in many cases, finding it did not agree with them. Have you any definite experience as to that?—That was not our experience.

Effect of arsenic and alcohol together.

1104. (*Dr. Whitelegge.*) Do you consider that alcoholism renders a person more liable to arsenical poisoning?—I think so. It struck me that it did. It appeared to me that the two things combined seemed to modify the action of each other.

1105. Did the 100 cases you examined more particularly bear out that view?—Yes.

1106. (*Mr. Cosmo Bonsor.*) You stated just now that you considered that beer should be manufactured absolutely free from arsenic. I presume you not only refer to beer, but to any article of food?—All articles of food. What applies to beer would certainly apply to other articles of food.

Tests arseni Beer.

1107. (*Professor Thorpe.*) Of course, that statement must have reference to some test for the arsenic?—Yes, presumably.

1108. I mean the thing must be subject to a chemical test?—Yes, you must be able to determine the presence of arsenic by chemical means. I know of no other means.

1109. So that the absence or presence of arsenic is defined by the test?—Yes.

1110. How is the analyst, therefore, unless the test is prescribed for him, to certify whether arsenic is there or not?—But he himself is the best judge. He uses the most approved methods of determining the presence of a poison, and we are in his hands. If he certifies that the substance is free from arsenic we are satisfied with that.

1111. Again, I would point out to you that every test after a time breaks down, because to every test there is a certain degree of sensibility attached. A man may be incapable of detecting arsenic in a gallon of beer, but he might be able to detect it in a barrel of it?—Well, if for analytical purposes he needs a barrel, we shall be pleased to secure a barrel for his researches. We would not limit the amount of the sample which we would give to him.

1112. But as a practical matter could an inspector under the Sale of Food and Drugs Act obtain quantities of beer of that order?—Yes, if it were necessary. We frequently get very large quantities of articles of food.

1113. Would it not be rather a *reductio ad absurdum* for a man to go into a public house and say, "I want a barrel of beer," and after buying it declare that it was for the purpose of analysis and have it divided into three parts; or, if a barrel was not enough for the purpose of analysis, to get three barrels, one of which he would leave with the publican, one he would take away, and the other give to the analyst?—If we are going to make analyses of such enormous quantities as that we should, if necessary, probably get the samples from the brewers. But our analysts say that one gallon is ample for their most minute test.

1114. That is for a particular test, but though a test for arsenic might break down for one gallon, it might be effective in a test with 10 gallons?—I do not know. I have no evidence whatever to lead me to think that that would be so. All things are possible, but that seems extremely unlikely.

1115. What I want to make clear is this, and I have no doubt you will recognise it. Your statement as to the absolute absence of arsenic may have no real value, because it is solely in relation to a particular test which may be applied to a particular quantity of material?—Anyhow, it seems to me that the tests are better applied in a laboratory than on the human subject. In this case a gigantic experiment has been tried upon human beings with very serious results. If we could obviate a repetition of such a thing by sending the analyst a gallon or even a barrel of beer we should be extremely glad to do so. There would be no difficulty about it.

Qua for of F Acts

1116. Have you formed any opinion as to what amount of beer these tests which are known to you should be made upon?—I know quite well that the infinitesimally minute quantities that you suggest may exist, might want a large amount of beer for their detection. But for all practical purposes, for all the purposes of ordinary human affairs, the analysts so far say that a gallon is enough; they say that if we send them a gallon that is enough for their purpose.

1117. So that, if you continued to operate under the Sale of Food and Drugs Act, you would require to take 3 gallons of beer for the purpose of analysis?—Yes.

1118. And that you think, with such tests as you know of, it ought to be reasonably sufficient in the interests of public health to check the possibility of arsenical poisoning?—Yes, I think so.

1119. (*Dr. Whitelegge.*) You say that you came to the conclusion, after conference with the public analyst, that a gallon is sufficient?—Yes.

1120. I want to be quite clear about this. Does that mean a gallon purchased, of which one-third goes to the analyst, or does it mean 3 gallons purchased.

of which one gallon goes to the analyst?—No; the analyst requires 1 gallon, so that we take 3 gallons.

1121. But you say in some cases a gallon was purchased?—Yes.

1122. But I understand you have gone beyond that now?—We took less usually; the usual quantity was a quart, but that was not enough for the detection of excessively minute quantities of arsenic, and, therefore, we took a gallon, and ultimately 3 gallons, for the purposes of closer investigation.

1123. As a matter of routine practice?—Not as a matter of routine practice, but to meet this specific emergency.

1124. So next year, and the year after, according to your view, if samples of beer are taken for analysis, it would be necessary to make 3 gallon purchases?—I do not think that would be necessary in all cases, nor as a routine practice. I should confer with the analyst again upon that, but so far as my present information goes, I do not think in all cases we should need to take those large quantities.

1125. (*Chairman.*) Generally a gallon would suffice, you think?—Yes, or even less.

1126. (*Professor Thorpe.*) Do you think that buying such large quantities of beer would in any way tend to defeat the object of your enquiry?—It would be a very serious obstacle, and, as I have suggested, we should probably have to get it either from the brewers, or adopt some other means of procuring it. It may be that the Sale of Food and Drugs Act, or some other Act in reference to it, may be amended as a consequence of this wholesale spread of illness, and this very serious loss of life. I hope it may be, to enable us to meet an emergency such as this.

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1127. Doubtless you are aware that sometimes inspectors have a difficulty in working the Sale of Food and Drugs Acts if they or their agents ask for anything unusual?—Yes, that is a difficulty.

1128. For example, in the case of milk, if they ask for a quantity which indicates that three portions are being required, that in itself arouses suspicion?—Any unusual quantity may arouse suspicion and no doubt it does sometimes, but that is a difficulty we meet as best we can, and we must do it. It is not an insuperable difficulty.

1129. You do not apprehend any serious difficulty in the case of beer from the fact of asking for three gallons, do you?—No, I think we should manage to get them in some way, from some sources. After all, the presence of a poison in the beer is a matter of infinitely more consequence than is contemplated by the Sale of Food and Drugs Act. It appears to me to be frivolous and trifling that a person who has sold a deadly poison is punished only to the extent of a fine of something like 20s. and costs. That seems to me extremely frivolous.

Penalties under F. and D. Acts inadequate.

1130. (*Chairman.*) That fine you would say is rather designed to check operations which comparatively are quite innocent?—Yes, quite so.

[The Chair was here taken by Sir William Church.]

1131. (*Chairman.*) Might I ask you to give the Commission the benefit of the conclusions that you have arrived at?—The conclusions that I have arrived at are, in the first place, that the exceptional sickness and mortality owing to arsenical poisoning have been due in Liverpool to poisoning through the medium of beer, that beer was the means by which the arsenic reached the poisoned person. The arsenic found its way into the beer from an impure glucose, and the arsenic in the glucose was due to the use of sulphuric acid containing arsenic in large quantities. Bostock's firm, as is well known, supplied the glucose, and it is equally well known that Messrs. Nicholson, of Leeds, supplied Messrs. Bostock with sulphuric acid containing arsenic. For many years Messrs. Nicholson supplied a pure acid, and, without any warning or communication with Bostock's in any way, they substituted acid containing arsenic for the pure acid.

1132. Is it within your knowledge that they supplied pure acid to Bostocks?—Yes, I have heard it stated upon oath at the coroner's court that for many years they supplied a pure acid, that they ran short of the pure acid (as I understand), and they substituted the arsenical acid. But it is only right to them to give their explanation, namely, that they did not know what business Messrs. Bostock's carried on. It is true that they addressed letters to "Messrs. Bostock, Sugar Makers," but at the same time they did not know, so they say, what was the nature of Bostock's business. Therefore they felt justified in sending sulphuric acid without going through the formality of enquiry, or warning Bostock's in any way. That appears to have been the ultimate origin of the arsenic in the beer.

1133. Were you present at the inquest when it was stated on oath that it was pure sulphuric acid which had been for some years supplied?—Yes. It was stated on oath that the acid had been analysed from time to time by Bostock's chemist, and found to be pure. In fact, he states that he was thrown off his guard by repeated analyses, and had therefore given up testing it, feeling so much confidence in the purity of the acid.

1134. They did not supply the ordinary commercial brown oil of vitriol?—They supplied an oil of vitriol which was free from arsenic up to a period, and then they suddenly substituted this arsenical acid. Perhaps I may as well mention, as it might interest the Commission to know it, that Messrs. Nicholson distinguished the two kinds of acids, using a red label for the pure acid and a black label for the arsenical acid. But when they made the change in the material, and sent to Bostock's acid containing arsenic, they did not change the label, but continued to send the acid bearing that label which, in their premises at all events, indicated purity. That appears to have been the source of the trouble. Those facts are all mentioned because I would venture to make one or two suggestions.

1135. Perhaps you will be good enough to make those suggestions?—It appears to me that a very much stricter supervision should be exercised over all the materials used in the manufacture of foods, beer included. That such supervision is necessary I think the facts which I have just mentioned very clearly prove. The manner in which I suggest this supervision should be exercised is somewhat on these lines. Inspections are now carried out by Government departments in other directions, for example under the Alkali Acts, the Factory and Workshops Acts, and many orders of the Board of Agriculture and the Local Government Board, and I am strongly of opinion that some such supervision should be applied to the preparations of food and drink, especially beer, which is so very largely used.

Stricter supervision over manufacture of food and beer ingredients necessary.

1136. Have you formed any opinion yourself as to whether there is any power for the inspection of the substances used as substitutes for hops and malt in brewing?—I am not aware that there is any power existing which would adequately meet the case. For example, the preparation of an article may take place in the district governed by one local authority, and the sale of it may take place in that under the supervision of another. The authority in whose district the article is sold has at present no power, so far as I know, of going into the district of the authority in which it is manufactured, for samples. The manufacture may take place in a rural district where inspection is very inadequate, as, for example, to quote a familiar instance in the case of cows. The milk is consumed in the cities, but is produced in rural districts. Now, powers are given to most of the great cities to go into the rural districts to make inspections and examinations. Similarly, I think that the Sale of Food and Drugs Act should be so amended as to enable samples of manufactured articles and also of ingredients used in the process of manufacture, to be procured at the place of manufacture or preparation for manufacture, and the officers of the sanitary authority in whose district the manufactured articles are sold should have that power. If an article, for example, is sold in Manchester, I believe that powers ought to be given to the Manchester Sanitary Authority to go, if they so wish, and supervise the manufacture of, or take samples of, the substances used in the manufacture. I do not suggest that that should be anything more than supplementary to the Government inspection, but I think it would be a good thing if those powers were given to the great cities.

Existing powers inadequate.

Government inspection and supplementary inquiries by sanitary authorities of great cities advocated.

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Question of warranty.

1137. I think you suggest that brewers supplying retailers, licensees, or managers of public-houses with beer should send with the beer a warranty guaranteeing the purity of the materials employed in its manufacture?—Yes ; that is a third recommendation which I would make.

1138. (*Mr. Cosmo Bonsor.*) Do you throw the responsibility in the first place on the manufacturer, and then check that responsibility by increasing the powers of the sanitary authorities or Government inspectors?—Yes.

1139. You are not going to relieve the manufacturer from responsibility?—No. I think recent events show the manufacturers certainly require a very close supervision.

1140. Is there any precedent for manufacturers giving a guarantee in respect of the article supplied in this way?—Yes ; it is frequently done.

1141. Could you mention one instance?—One instance was mentioned by Professor Thorpe, in which a milk contractor gives a written warranty certifying the milk to be pure and genuine and wholesome.

1142. But that is hardly a manufactured article, is it ; it is a production?—That is so ; but the same applies both to butter and margarine.

1143. Under a special Act?—I think so ; but it is a very frequent thing for warranties to be produced. We will, if you like, take the case of fruit wines, that would be a very good case in point.

1144. I am not objecting ; I only want to know if there is any precedent, as it is a most important matter?—I know that the brewers themselves do employ analysts, and we have had ample knowledge of that. At the same time, the analyses which these gentlemen make are not directed to questions affecting the public health, but to questions affecting the suitability of the materials for the manufacture of the beer. That, I take it, is what they direct their efforts towards.

1145. (*Professor Thorpe.*) But in this particular case, confining ourselves for the moment to the brewers, is it not now the fact that before a brewer uses any one of these malt substitutes he is taking pains to see that the substitutes sold to him are free from arsenic?—I am quite assured that he wishes to do so, but he has not succeeded ; his pains have resulted in nothing. We have the very strongest evidence of that. If his efforts had been successful and adequate there would have been no Arsenical Commission.

Guarantees of purity of ingredients.

1146. I am talking of the things which have arisen in consequence. Is it within your knowledge that the manufacturers of these things are themselves taking steps to furnish the brewers with the guarantee of purity?—Probably they are, just now.

1147. Is it at all unlikely that that practice will die down and that those guarantees will not be forthcoming in the future?—I would prefer to see it made obligatory than that it should be optional. I think after this terrible lesson it would not do to leave anything to chance, or to the views and feelings of those who may be engaged in that special business.

1148. But, of course, you have a double check, have you not, in this case? No doubt the manufacturers of invert and glucose will take steps to assure themselves of the purity of the oil of vitriol which they take into use?—They did so before ; Bostock's, for example, assured us that their chemist was assiduous in his examinations, but we know that he failed. Our present system has broken down ; it is not strong enough ; it is not complete enough.

1149. But under your coming system, if I may say so, the question will be after all one of testing?—Quite so. We have very great confidence in Government inspection. We think the employment of more supervision would be attended with very good results.

should be compulsory.

1150. I wish to make this matter quite clear to you as to what the operations on your suggestion would be. In the first instance, the man takes oil of vitriol ; no doubt he will get a guarantee with it. He will take steps to authenticate the guarantee by means of the chemists he employs. He will in addition have to furnish to the buyer of his product a certificate or warranty of its purity?—Why will he have to? He will not have to. He may if he likes, but he is not obliged to. What we want to do is to make that compulsory.

1151. Do you think brewers nowadays would take that stuff into use without a warranty?—I do not think he would nowadays, but we have to look to the future.

1152. But I am referring to the future in so far as oil of vitriol enters into manufactured articles. Do you think it likely that the brewer will neglect nowadays such a precaution, and allow arsenic to enter into beer? —Well, no, I do not think he will. But the same remark might be applied to any other question requiring an Act of Parliament: "Do you think that any class of man would do this and that and the other?" Probably the answer would be no, but none the less the Act might be needed.

1153. But prior to this, was it a notorious fact that glucose might contain arsenic? It might be known to one or two persons, or it might be found in a text book, or in an occasional work ; but it was not a matter of public notoriety amongst analysts that such might be the case?—Quite so.

1154. And that being the case, do you think it is at all within the region of probability that any relaxation of caution will take place in so simple a matter as testing for arsenic?—I think it is quite likely ; I think it might. At all events it is just as well to avert it if we can by inspection and supervision.

1155. Yes ; but my point is that your suggestion is very elaborate, and would require somewhat costly machinery for doing something which there does not seem to be any public necessity to do?—I must answer in this way: I can scarcely think it possible, but if it should be considered that beer itself is an unimportant article of consumption, the same Act might be made to apply to all articles of food with very great advantage, so that we should protect other things in which glucose, etc., may be used, and which have hitherto been free, and which are free to-day, but which may be contaminated to-morrow. We do not know.

1156. But I suppose the same warranty as to purity would attach to any sample of glucose if it were known that it is derived incidentally from sulphuric acid?—There are manufacturers of all grades and importance with works of various sizes, and it is as likely as not that some of the smaller ones would very quickly forget about this calamity. In fact, to-day almost, arsenical beer is being sold ; it is an extraordinary fact, and I would like to know how you would explain that? It simply shows in my view that there is a necessity for some very strong supervision.

1157. No doubt arsenical beer has been sold from time immemorial, and it is only the accident of a certain large quantity of arsenic getting by mischance into Bostock's glucose that has created this trouble?—Possibly, and it is in order to avert a repetition of these very grave circumstances that I would recommend these precautions.

1158. (*Chairman.*) I presume really that the great safeguard produced by the warranty would be that there would be someone responsible who could be come down upon if an article is found impure, and you contend that that is preferable to the present voluntary system, when there is nobody to come down upon?—Yes ; at the present time there may not be any warranty at all.

1159. You say that the stipulation of a voluntary warranty may or may not be carried out?—Exactly.

1160. But under the obligatory system if a person's goods do not come up to his warranty he could be come down upon and prosecuted?—Yes.

1161. (*Professor Thorpe.*) You say that the application of the Food and Drugs Act is limited because you cannot come upon the manufacturer but only upon the retailer of the article?—That is one reason.

1162. What I want to get from you is the machinery by which you can make use of the provisions of the existing law to effect what you want. You could have gone for the brewer, I understand, if the publican had had a warranty?—Yes.

1163. Is there anything to prevent any publican who has a free house from requiring a warranty from a brewer? —There is nothing to prevent him asking him for it.

1164. And he can refuse to deal with that brewer if he does not get it?—He can if he likes, but probably he would lose his own business if he did so.

1165. Why?—There may be a demand for that particular kind of article which is sold there, and he cannot get it with a warranty. On the other hand, there are scores upon scores of houses in which the licence is in the hands of the brewer—the great majority.

1166. I referred to free houses?—Yes, in the relatively few free houses it would perhaps be less difficult for him to get a warranty.

1167. You say it would be less difficult to get the warranty in the cases of the really free houses?—Yes.

1168. He could demand it, and presumably he might get it?—Yes.

1169. In the case of tied houses you want some machinery which connects the manufacturer of the article with the licensee?—Yes; and a warranty, I think, would do that.

1170. Do you not think it might be possible under the existing law, without even the application of a warranty, to connect the actual manufacturer of the article with the sale through his own agent of the substance?—It would be very difficult; it is very difficult indeed.

1171. But the case has never been tested, has it?—Similar ones have, under the section which alludes to a guilty knowledge. It could be tried under that, but you cannot prove what a man's knowledge is. You cannot prove that a man had guilty knowledge that such and such a thing was in the article sold.

1172. You think, do you, that the law requires amendment so as to connect the licensee of a tied house with the brewer?—Yes, distinctly.

1173. (*Dr. Whitelegge.*) The warranty you think of goes so far as to be a list of the materials employed?—Yes.

1174. It differs from an ordinary warranty under the Sale of Food and Drugs Act?—Yes; in most of those articles the constituents are known.

1175. You would provide for a list of the materials employed, including, in the case of beer, malt and hops, I suppose?—Yes.

1176. And the proportions in which they are used?—I am merely making a suggestion in regard to the guarantee of the purity of the article. I do not think it is so much concern what proportions of ingredients are used, so long as there is a guarantee of purity.

1177. Do you think the guarantee of purity which is obtained from a previous certificate—in the case of Bostock's, for example, from Nicholson—should form the basis of a certificate issued by Bostock's that the ingredients were pure?—Clearly so. The warranty must apply to the manufacturer of the acid as well as to the manufacturer of the glucose, and in turn to the manufacturer of the beer.

1178. (*Professor Thorpe.*) That was not quite what was in my mind. What I was referring to was an independent warranty. I take it you did not mean that Bostock's warranty should be based upon Nicholson's warranty alone, without any further questioning upon the part of Bostock's chemist?—No. I think it very necessary that their stage of the proceedings should also be supervised.

1179. And you believe that the result should be independently tested by them?—Certainly.

1180. (*Dr. Whitelegge.*) The warranty given must be based upon the responsibility of the person giving it, and must not be dependent upon warranties received by him from those who supply him with his materials?—Quite so.

1181. Would this system which you suggest protect the individual consumer of an article such as beer?—I think it would.

1182. He would not know anything about the warranty or the list of ingredients, would he?—It might be carried a step further if necessary.

1183. But you think of it as coming down to the retailers?—I think that would be a sufficient warranty arrangement, because the actual retailer would be dealt with directly by the Sale of Food and Drugs Act. The man who sells the article is the one who would be proceeded against in the event of any impurity being present.

1184. You told Professor Thorpe, if I understood you rightly, that if there were a warranty you could proceed against the manufacturers in the case of beer?—Yes; I believe so.

1185. Directly, or after proceeding against the retailer?—After proceeding against the retailer, who would produce his warranty, and that would be a sufficient discharge in his case.

1186. I understood you to recommend that there should be power on the part of officers of the local authority of any district in which the food is consumed to obtain samples from the place of manufacture?—Yes, if they desire to do so.

1187. Would you make any distinction between one authority and another, or would you extend it to all sanitary authorities alike?—I see no objection to such an extension; but primarily I had in my mind the great cities.

Great cities should have power to deal with food manufactured outside their own areas.

1188. And you would let the samples be taken at whatever distance from those cities?—Yes; anywhere, so long as the article consumed is used in a great city. I should like to see the sanitary authority of that city armed with powers to go into other districts from which the food came, and take samples.

1189. Would not that be difficult in such a case as Bostock's, who supply sugar, I imagine, over a considerable part of the kingdom?—I do not think it would be more difficult than in the case of another article in which the power already exists. It would not be more difficult than is now the case in the matter of milk. It would be difficult unquestionably, and I do not suggest it with the view to relieving any other responsible people from their obligation at all, but merely as an additional safeguard for the great consuming centres.

1190. If Messrs. Bostock supply sugar to a large number of brewers who distribute their beer over a large portion of the kingdom, would that not give a large number of local authorities under the scheme you suggest the right to come at any time and take samples?—Yes, it would.

1191. Does that condition arise under the precedent of milk, which you mentioned?—Yes, certainly.

1192. A large number of local authorites have the right to take samples of milk from a particular farm?—Yes; Manchester, Liverpool, Leeds, and other places might all be sending down to one farm, there is nothing to prevent it.

Difficulty of applying Section III. of F. and D. Act of 1875.

1193. (*Chairman.*) I think you wish to make some further suggestion for consideration as to the repeal or modification under Section 3 of the Sale of Food and Drugs Act of 1875?—There is always a difficulty in the administration of Section 3 of the Sale of Food and Drugs Act in proving that the person summoned had any knowledge of the composition of the article mixed or sold; and the question of whether that clause could be amended or modified in any way is what I wish to call attention to. I have nothing further to say about it. It is a clause which is exceedingly difficult to deal with—in fact, it is very seldom that any proceedings are taken under that section. It is an impossibility to prove what a person knows and what he does not know.

1194. (*Dr. Whitelegge.*) Does anything occur to you short of actual repeal of the section of the Act—Section 5—which requires guilty knowledge to be shown in the case of proceedings under Section 3?—No. The phrasing of Section 6 is a very much simpler one. "If the article is sold to the prejudice of the purchaser." The absence of proof of guilty knowledge is no defence in proceedings under that section, and it is very much more useful and simple one than the other. It is, perhaps, a lawyer's question, but it is one which we find great practical difficulty in working.

No prosecutions under F. and D. Acts in Liverpool in respect of arsenical beer.

1195. (*Professor Thorpe.*) Have you brought any cases in Liverpool under Section 3?—No.

1196. What has been your fate when you brought them under Section 6?—I have not brought them before the magistrate. They were laid under Section 3. They were not taken before the magistrate at all.

1197. Have you not taken any action under the Sale of Food and Drugs Act at all?—No final action.

1198. You are waiting for the decision in the Manchester appeal cases, are you?—No; we have withdrawn our cases. We were advised by our legal advisers that they were cases which should be withdrawn.

1199. Do you know on what grounds the withdrawa was made?—There were several grounds.

1200. Can you state them?—The difficulty of proof of guilty knowledge.

1201. They were brought under Section 3, then?—Yes.

1202. Were they all intended to be brought under Section 3?—Yes, and there were other grounds also.

1203. Why did you not proceed under Section 6?—The cases in which we had laid informations related to samples taken at the very commencement, in connection with which it was obvious that there was no guilty knowledge on the part of the brewers; and therefore the cases

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were withdrawn under the advice of our legal department. They were cases of samples taken very early, which had long been disposed of, and they were taken at a time when no one knew—neither the brewers or anyone else—the source of the arsenical contamination. In that case I was guided altogether by the law officers of the Corporation.

1204. Do you yourself see any difficulty in bringing a case under Section 6, namely, that it is not of the nature and substance and quality demanded?—We might have done that; but it did not commend itself to me as appropriate or suitable to institute what would practically be a bogus prosecution against some innocent person, when we ourselves knew what was the source of the mischief, and knew perfectly well that these people against whom we might have proceeded were absolutely uninformed and had no knowledge and no means of knowing.

1205. I am not going into the ethics of the case at all, but the point you had in view was to stop the sale of this article?—Exactly; and that is what we did.

1206. How? Only by the voluntary action of the people?—It was stopped within two or three days; whereas by any action under any existing law it might have gone on for three weeks. Our object as a sanitary authority, as a body guarding the public health, was to guard the public health, and that we did effectually in the way I have already described.

1207. But you would not have hesitated to bring a milkseller into Court under Section 6, would you, although he had no knowledge that the milk he was selling contained water?—That is an entirely different thing. One is fraud—a perennial fraud, day after day and year after year—that is a common fraud; whereas this was a thing without precedent. At that time it was regarded in the light of an absolute accident.

1208. True; but with much more dangerous consequences?—Therefore it was more promptly dealt with. If it were an offence, it was not an offence that could be adequately dealt with by a fine of 20s. inflicted upon an innocent person.

1209. The object there was not to get a fine, but to attain publicity. The fine is not a deterrent so much as the taking of police action, which would be followed by a legal decision, you hoped, in your favour. That is what you wanted, to secure a conviction with a view to stopping the sale of these articles?—The only point was that we stopped the sale of it several weeks before it would have been possible to have obtained a conviction. We do not think it worth while to bait a trap for publicans with human lives. Our object is to act at once.

1210. (*Chairman.*) You say the work of the authorities of large towns would be enormously facilitated by the enactment of recommendations such as you propose—that is, that the officers should have powers to go into the districts where the manufactured article is sold. You seem to lay great weight upon that?—Yes; I think that would be a very valuable power.

Poisonous substances should be labelled.

1211. And make it compulsory that manufacturers sending out substances containing poison should label them?—Yes, should so label them; and also that it should be the duty of the manufacturers of food stuffs to ask for and use materials free from poison, that they themselves should look out for that point on their own account.

Question of

1212. (*Dr. Whitelegge.*) Have you had any experience of proceedings on warranty after proceeding against the retailer?—Yes.

1213. Have you been successful in them?—Yes.

1214. Would it be convenient if under a different law the manufacturer could be associated in the first hearing when a warranty is about to be produced?—I think it would. I think it would save time and simplify things very considerably.

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1215. (*Professor Thorpe.*) With reference to the last suggestion in your *précis*, that manufacturers sending out substances containing poison should label them, how is that going to touch the oil of vitriol maker, supposing he labels his oil of vitriol "Poison"? Oil of vitriol, *per se*, is poison?—Yes, I thought of that. It is obviously poison—corrosive, and no one would think of drinking it. At the same time, if it contains something which it ought not to contain—an additional poison which could find its way into food products, in connection with which sulphuric acid is to be used—then he should so label it. In fact, I can see no harm in his labelling it "Poison," even if it is pure acid. He can then label it "Pure sulphuric acid"—that is to say, label it what it is.

Labelli poisons

1216. What you want to do is to differentiate between deleterious sulphuric acid, so to speak, and the pure article?—Yes.

1217. Why not at once say "sulphuric acid containing arsenic," or "sulphuric acid free from arsenic"?—Yes, that is an admirable suggestion. I simply put it in its broadest way.

1218. I venture to think that it is not sufficiently distinctive to put merely "Poison." It does not cover what you wish it to cover?—Quite so.

1219. (*Chairman.*) I take it that these recommendations of yours do not apply to any particular body. They are general to everyone, I presume?—That is so, as well as to this specific subject.

1220. (*Sir William Hart-Dyke.*) Would you suggest that in each case the purchaser should ask for a guarantee of purity?—Yes.

Respon ty of p chaser food in dients to be p ous.

1221. Do you think that security would be the outcome of that demand alone or do you think the purchaser in such a case should have better protection in any further way than by this simple demand, because you may ask for a thing and not get it?—Quite so. My suggestion is to impose upon him the obligation of asking for a pure thing, letting the manufacturer of sulphuric acid know what the acid is required for. If that is an obligation which rests upon the purchaser it is one more safeguard between the sulphuric acid manufacturers and the public.

1222. Has it not been indicated with reference to this catastrophe and loss of life that Messrs. Nicholson were not aware for what precise purpose this material they were selling was to be used?—That is what they say.

1223. It has been urged, has it not?—That is their statement, that although they supplied Bostock's with pure acid for 10 years they did not know what Bostock's business was, although letters from Nicholson are addressed "Messrs. Bostock, Sugar Makers." They say they did not know what Bostock's were; but without warning or without troubling to inquire what their business was they substituted the arsenical acid for the other.

1224. Made from a different and vitiated source, and hence the disaster?—Yes.

1225. You think if Messrs. Bostock had been compelled by Act of Parliament to state for what purpose this material was to be used this disaster might have been avoided?—Yes. I also think that it should be a primary recommendation that manufacturers sending out substances containing poison should so label them. If the sulphuric acid, which in itself is poison, contains arsenic it should be so labelled. Then the person who receives it will know what there is in it, and he will guard himself. These two recommendations are safeguards upon both sides.

1226. It would be a two-fold safeguard on the part of the vendor and the vendee?—Quite so.

Sir WILLIAM HART-DYKE in the Chair.

Mr. ALFRED GORDON SALAMON, Vice-President of the Society of Chemical Industry; Member of Council of the Institute of Chemistry; Consulting and Analytical Chemist; called, and Examined.

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1227. (*Chairman.*) You are a vice-president, are you not, of the Society of Chemical Industry?—I am.

1228. And a member of the Council of the Institute of Chemistry?—I am.

1229. You have also been the consulting and analytical chemist, with considerable practice and experience, spreading over 17 years, of the technology of brewing?—Yes.

1230. May I ask you how this connection came about with regard to the technology of brewing. Have you been employed much by the brewing trade?—Very largely employed by the brewers throughout the country to advise them as to the best materials to employ for arriving at satisfactory fermentations in connection with the barleys they have to employ.

1231. But most of the large brewers employed their own analytical chemist, did they not?—I am consulting chemist to many large breweries.

1232. For instance, you might be summoned by any one of those whom we may call for the moment your clients, and they might rely on your services at any time?—They consult me with reference to any questions connected with the technology of their work.

1233. And you claim to be not only an analytical chemist, but a specialist, as regards the brewing trade?—I think I may fairly claim that.

1234. You have kindly had printed for us a statement of the principal points on which you would like to give information, and I think you will admit the first two or three pages refer chiefly to things which lead up to your being summoned by Mr. Groves when this serious state of affairs occurred at Manchester?—They bear upon the history of the epidemic as showing the steps which were taken by Mr. Groves and subsequently by his colleagues to unravel the mystery and arrive at the truth in respect of the poisoning.

1235. As a result a committee of experts was appointed, was it not, to advise the Manchester brewers as to what they should do in the emergency?—It was.

1236. Mr. Groves will be shortly giving evidence here, so I do not propose to question you so much on all these earlier stages which you go through in your *precis* which led up to this enquiry; but I think I may put it briefly by asking you whether Mr. Groves, having suspected something seriously wrong with regard to his beer, immediately sent samples to you on November 17th to be examined, on the supposition that some poisonous form of alcohol was present?—Yes. At that time he had reason to believe that the beers contained an undue amount of what are termed the higher alcohols, that is a comprehensive term embodying a great many substances, and he asked me to test the beers to see if I could find those alcohols present in the particular samples.

1237. On December 22nd did you receive an intimation from him that there was a grave suspicion that there was arsenic?—Yes.

1238. That the mischief which caused this great alarm on his part was not occurring from the higher alcohols you have mentioned, but was proceeding from the actual presence of arsenic in the beer?—That is so. With your permission I will hand in the letters.

1239. But other substances did come under suspicion, did they not? Was not there a suspicion on his part at one moment that some poisonous ingredient had got into the beer through the medium of hops?—The first suspicion was that the arsenic was introduced by the hops; it had been stated that a hop merchant in Manchester, who was not a beer drinker, had developed symptoms of poisoning, and it was assumed he had done so through handling the hops. That was subsequently disproved.

1240. That was clearly disproved, was it?—Clearly disproved.

1241. That any mischief accrued from the hops?—Yes.

1242. Then you were informed that there was a strong suspicion as to brewing sugars, and upon analysis you found arsenic in samples of these sugars there were sent to you from Messrs. Groves and Whitnall's brewery?—Mr. Groves brought up samples of all the raw materials he employed in his brewery, and as soon as he stated that there was a possibility of the sugars being contaminated—invert sugar only at that time was supposed to be contaminated with arsenic—I at once proceeded to make analyses, with the result that I soon discovered that both the invert sugar and the glucose of Messrs. Bostock supplied to them was grossly contaminated with arsenic.

1243. You found that at once?—Yes.

Appointment of expert Committee by Manchester Brewers' Association,

1244. Then on November 22nd did you advise Mr. Groves that an expert committee should be appointed, not only to advise his firm specially, but also the Manchester Brewers' Association?—I did that for this reason: Mr. Groves was quite prepared to take the inquiry upon his own shoulders; but I pointed out to him, after reflection, that if any material that he was using in his brewery was contaminated with arsenic, the mischief would probably be widespread, and would not be confined to his particular brewery; that if it were a case of malicious addition of any arsenical compound to the beer or materials, it would probably be a case of murder, and I did not feel that I ought to take upon myself the responsibility of acting alone in such a case, I did not feel Mr. Groves ought to bear an undivided responsibility, and I advised the appointment of a Committee to investigate thoroughly, with the view to stopping the further spread of the mischief, and I suggested the names of the gentlemen who subsequently agreed to act.

1245. In fact, you wished to cover the whole ground that could, humanly speaking, be supposed to be covered by the supply throughout the district?—Exactly; and to that end I suggested that Mr. Groves should place himself in communication with the members of the Association of Brewers in Manchester.

1246. Who were the members of this expert committee?—The members of the expert committee were presided over by Mr. Fletcher Moulton, K.C., and consisted of Sir Lauder Brunton, Dr. Stevenson, Dr. Luff, Dr. Buckley, and myself. We constituted the expert committee.

1247. Sir Lauder Brunton is a physician, is he not?—An eminent physician.

1248. And Dr. Stevenson has had very large practice as a specialist in poisoning?—He is the most famous of our toxicologists. He and Dr. Luff are chemical advisers to the Home Office, as is well known.

1249. (*Sir William Church.*) Dr. Luff was also a physician?—Yes.

and work by them,

1250. (*Chairman.*) You informed us further that this committee commenced its work in Manchester on November 29. Have you anything further to say with regard to the progress of that committee, what determination they arrived at, or what steps they suggested should be taken?—The first meeting of the brewers' committee was held at Manchester at 9 o'clock on the morning of the 29th November; that was seven days after the first visit of Mr. Groves to my laboratory. At this meeting we were informed that the poisoning through beer was then known to be widespread, and that it was by no means restricted to any one particular brewery. It was further stated that Dr. Tattersall had made important discoveries as to locating the mischief in the invert sugar supplied by Messrs. Bostock and Company, of Liverpool, and that Messrs. Groves and Whitnall had further proved it to exist in the glucose supplied by the same firm. When I compared the analyses which I had made—they were numbered samples—with the references which Mr. Groves then supplied me, I found that this absolutely agreed with my own observations, and therefore we had strong *prima facie* evidence that the mischief might be located in respect of the invert sugar and the glucose supplied by Messrs. Bostock and Company.

Then a long discussion followed as to the means to be adopted for combatting the mischief, more especially with respect to the prevention of its spreading. Dr. Luff, and Dr. Buckley then left to inspect the hospital

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cases, it being arranged that the gentlemen should, if possible, meet me and be present at the meeting of the Manchester Brewers' Association, which we had been asked to attend.

I duly attended the meetings, first of the Committee specially appointed to report to the Association; and, secondly, the meeting of the Association, which was very largely attended. In my opinion fully one hundred were present.

The meeting was addressed by the chairman, Mr. Rothwell, who then invited Dr. Luff and myself to speak with a view to suggesting what measures, and particularly what preventive measures, should be taken. I then stated that this was evidently a case of widespread poisoning of a terrible character, and that to prevent further poisoning of the public, vigorous united action by the brewers was indispensable. I stated that the investigation had thus far proved that the brewing sugars recently supplied by Messrs. Bostock and Co., Limited, were poisonously contaminated. I could not then state what other materials were not also contaminated. I did, however, state that it was evidently the duty of the brewers to place an embargo upon all beer in the manufacture of which Bostock's sugar had been employed, to recall such beer, and to destroy it if found to contain arsenic. Further, it was their duty to organise a system of testing so that all beer sent out for consumption should be certified as free from arsenic. I asked that to this end they should place themselves unreservedly in the hands of their Committee, who would be advised by the Expert Committee, and that each brewer should permit the Committee or any of its members to visit each or every brewery to take samples and inspect plant, casks, beers, and materials employed. Dr. Luff strongly supported my demands. We then withdrew and the meeting deliberated, and we were shortly afterwards informed that the meeting had by resolution given full effect to the recommendations, and had pledged itself to faithfully carry them out. I cannot too strongly insist before the Royal Commission upon the genuine loyalty with which the Manchester brewers have redeemed this pledge.

On the same afternoon I had a prolonged interview with Dr. Tattersall, and subsequently with Dr. Niven, from whom I received most important information. Meanwhile, the other members of the Committee were proceeding to investigate independently on their own respective lines.

1251. How many breweries are represented on the Manchester Brewers' Association?—I believe they number some 50 odd. I believe there are about 150 members, including those connected with the trade.

1252. Both of Manchester and Salford?—Yes. But I think the brewers number about 50.

1253. Would that 50 be restricted to Manchester and Salford alone, or include Liverpool, for instance?—I do not think it goes to Liverpool, but it goes outside Manchester, because I have had samples from members of the Association sent to me from other parts than Manchester.

1254. That might indicate a little alarm on the part of those who did not belong to the Association. They need not have sent those samples simply because they belonged to the Association?—I mean samples sent as members of the Association.

1255. Did any recommendations emanate from this Committee with respect to any other brewers outside Manchester, outside the Association?—Our recommendations were published, in the form of reports which I have here, and presumably they were acted upon by others. I have reason to believe they were. Appendix No. 5.)

and reports.

1256. They appeared in the public Press?—Yes. Publicity was given to our recommendations at the earliest possible moment, with the view to getting them widely acted upon.

1257. And there being a general alarm amongst the public and in the trade at the time, it would be natural that intelligence of that kind would be eagerly read?—That was the view of the Association.

1258. Any hint given to the Association at that period would be a hint to the public and the trade, a kind of general caution?—Quite so.

1259. It says in your *précis* that it was proposed that they should place themselves unreservedly in the hands of their Committee, who would be advised, and that each brewer should permit the Committee or any of its members to visit any brewery. Of course, that being agreed to would only apply to the Association?—That only applied to the Association. It included, as far as I know, all the brewers of Manchester.

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1260. When all these matters were published, it would not throw that incubus on other brewers except the brewers of the Association?—No; but it did include all the brewers of Manchester and district, as far as I know.

Arsenic Bostock sugars.

1261. You had some 15 samples handed to you, did you not, by Dr. Tattersall for investigation, and you made a careful analysis of them?—Yes. Dr. Tattersall gave them to me at the meeting which I had with him on November 29th, with a letter of identification stating that he had obtained them from Messrs. Bostock and Company, Limited, of Garston. He stated they represented the raw materials which were being employed both at the time of his visit on the 23rd in the manufacture of glucose and invert sugar, and also the finished products as they were being sent to the brewers. He further told me that portions of the above samples had been removed for the purpose of analysis. The samples were delivered by him to Professor Delépine for the purpose of analysis and he handed to me those portions which had not been used. I then made careful analysis of these sugars and raw materials. I soon arrived at the conclusion that the materials which were grossly contaminated with arsenic were invert sugars and glucose. The other raw materials employed, and enumerated by me in the list, were not contaminated with arsenic, with the exception of the sulphuric acid employed in the manufacture of the invert sugar and the glucose. I soon found that this was very dangerously loaded with arsenic. I have here a sample of some of the acid I took, about a dessert spoon full of the acid. I precipitated the arsenic contained in it as the yellow sulphide of arsenic. This was diluted in order to obtain the proper precipitation, and the specimen will show the contamination of that acid which was employed for the manufacture of the invert sugar and of the glucose. (*Specimen exhibited.*)

1262. These raw materials all emanated, did they not, from Bostock's firm?—I was so assured by Dr. Tattersall.

1263. The Commission do not wish to bind you to statements in regard to researches which are not yet quite completed as regards analysis and other matters, but in part of this document you have kindly sent us you indicate that you would like, perhaps, to be further examined in regard to certain researches you are now making?—I should, because my analyses are not complete, more particularly with respect to the traces of arsenic and the proper means of quantitatively determining those traces.

Quan arsen Nich acid,

1264. I think it would be useful at this time if you could give this information to the Commission, as to the highest and lowest quantities respectively of arsenic you have found in any of these raw materials of Messrs. Bostock?—As regards the sulphuric acid, I found the determination of the arsenic a matter of considerable difficulty with the view to arrive at uniformity of result, because it was so loaded with arsenic that the arsenious acid precipitated came out as a copious deposit. I regret that the Coroner has the sample of acid at Liverpool, and I am not able to show it to you. I hope I may be permitted to show it at a later stage. The arsenious acid has crystallised out, and kept on crystallising out, from the acid, and therefore it made it difficult to determine with uniformity what percentage of arsenious acid was present in the sulphuric acid, but it may be taken that my results varied from 0·99 per cent. to 1·7 per cent. of arsenious acid. As regards the glucoses, they varied from 0·04 per cent. to 0·07 per cent.

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1265. (*Professor Thorpe.*) What are limits in the case of the glucose?—From ·04 per cent. to ·07 per cent.

1266. (*Sir William Church.*) The sulphuric acid was practically speaking a saturated solution of arsenious acid?—Indeed it was. Perhaps I may be permitted at this stage to show some specimens which will bring home to the minds of the Commission the extent to which these sugars were contaminated.

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1267. (*Chairman.*) I think we had better conclude first the quantities found. What do you say with regard to invert sugar?—They varied within similar limits. The samples I have examined of Bostock sugar, both the samples of Dr. Tattersall and the various breweries from which I took them, varied considerably, as might be expected, and I find that the limits I have given will fairly cover them all.

1257*. (*Professor Thorpe.*) Do you say that the amounts in the invert were the same as those in the glucose?—Substantially; they varied a good deal.

1258. But they were the same?—Between the same limits.

1259. That is surely not what one would expect, because the same proportion of sulphuric acid is not used in the two processes?—There was probably less, on the whole, in the inverts than there was in the glucose, but they varied very much. In all cases they were dangerously loaded with arsenic.

1270. But as a practical matter, only about one half of the oil of vitriol would be used in the manufacture of the invert than in the manufacture of the glucose?—That would be so.

1271. Therefore you would expect the amount of arsenic to have relation to the oil of vitriol used?—That would depend on the condition of the animal charcoal in the manufactory at the time the invert was made. The animal charcoal absorbed a very large proportion of arsenic in the process; that we ascertained at a later stage.

1272. (*Sir William Church.*) During the filtration of the glucose?—Yes.

1273. (*Chairman.*) You said that you were supplied by Dr. Tattersall with the list of the different breweries in Manchester?—I was.

1274. Which were supplied, previous to the detection of the epidemic, by Messrs. Bostock and Company?—And also by Dr. Niven.

1275. Is that list practically complete?—I believe it to be complete.

1276. I think we should be anxious in any case to have the names of these brewers whose beer was found to be arsenical?—Perhaps you will permit me to hand them in?

1277. Yes. You have your samples, and I presume you will have no difficulty in giving the names. Would you take it that the samples sent to you and examined by you were sent as specimens that would be sent to each one of these brewers in Manchester?—I do not quite follow you.

1278. My point is this, that you had a large number of samples from Messrs. Bostock and Company that were being sent out; you examined these samples, and you found a certain number of them contained a great amount of poisonous matter. I understand now that you detected that the beer supplied by these different firms was also poisonous?—I visited these various breweries.

1279. How do you differentiate between those breweries in Manchester which were selling beer that had a poisonous ingredient in it at the time of this epidemic, and those which did not?—By analysis.

1280. By analysis of each?—Yes. I visited these various breweries, and in many cases I took samples myself, and in other cases the samples were sent to me, and they were distributed amongst my colleagues of the Committee and we analysed them.

1281. (*Professor Thorpe.*) Had you reason to know that these samples which were obtained by Dr. Tattersall from Messrs. Bostock were being distributed to the various breweries?—I had.

1282. (*Chairman.*) There were two analyses, one of the raw materials from Messrs. Bostock, and the other, which was, of course, the important one, of the actual beer being sold by every brewer in the Association?—He handed me a list of the customers supplied in the Manchester district by Messrs. Bostock and Company, which list he had obtained from them at the time of his visit, and he marked certain names of brewers on that list, out of which clinical cases had arisen, and investigations were proceeding in respect of these clinical cases. I found that list was confirmed and somewhat expanded by Dr. Niven subsequently, and then I confirmed the experience of these two gentlemen by the analyses which were made of the beers that came from these breweries in question.

1283. (*Sir William Church.*) Is that the 18 breweries you refer to in your *précis*?—Yes; there were 18 breweries in Manchester supplied by Messrs. Bostock and Company, and out of those, eight breweries had cases traced to them of arsenical poisoning.

1284. Do you mean traced by the Medical Officer of Health from the symptoms?—Traced from the symptoms, and subsequently confirmed by analysis. But they were traced in the first instance by the symptoms.

1285. (*Chairman.*) Did you find that all the brewers who had been supplied by Messrs. Bostock had arsenical beer on their premises?—I think I may say that all the 18 brewers who were thus supplied had their beer contaminated with arsenic, but not in all cases was it poisonously contaminated. In some of the cases there were only traces, because they were using a very small proportion of Bostock's sugar. It became really a question of a trace which apparently did not give rise to the poisonous symptoms which were traced from the clinical cases. They were not what one would call cases of gross contamination. In only eight out of the 18 was there evidence of gross contamination by arsenic.

Proportions of Bostock sugar used varied at different breweries.

1286. (*Sir William Church.*) I suppose the assumption being that the beers were contaminated in proportion to the amount of Bostock's materials used. But were not other people's materials used also in Manchester?—Yes.

1287. (*Mr. Cosmo Bonsor.*) And possibly the mode in which the materials were used?—Certainly.

1288. I anticipate that if a considerable amount of priming with Bostock's invert sugar was used that beer would be more contaminated with arsenic than beer in which only arsenical glucose was used for brewing?—That is so, because during the process of brewing we have found a considerable proportion of the arsenic is eliminated. Yeast notably appears to have the power of absorbing or abstracting a very considerable quantity of arsenic.

Greater liability of contamination from priming.

1289. (*Chairman.*) You mention in your *précis* that an examination was made of casks which had previously contained beer, and that scrapings from the casks were taken, and that a very thorough examination was made with regard to the presence of arsenic?—I considered it most important to know that the cask plant had not become impregnated with arsenic.

Casks had not taken up arsenic.

1290. Would there be any other portion of the plant in the brewery that might require the same examination with the same object?—I did examine it, but the cleansing of the plant of a brewery is so very thorough and complete, and necessarily so, that I found, as I had expected, that the plant itself was in no case contaminated. What I was afraid of was that the casks might become impregnated with arsenic through absorption by the wood, and therefore I divided the test into two phases. I scraped the surface of casks which I knew had contained the poisonous beer, and having done that I made deep cuts into the casks and submitted them to analysis. In no case did I find anything but a negligible trace of arsenic. Therefore one was justified in stating that the cask plant was free, and that they were entitled to continue its use.

1291. You state that the proportion of brewing sugars employed was found to be about 12 per cent. upon the weight of malt as an average quantity. Is it not true that different brewers use different quantities for the same class of beer?—Yes, it varies with the type of barley they employ. If they employ foreign barley they would use less of the brewing sugars; if they employ heavy land barleys they would want to use more. It would vary very much in that respect, and I found a considerable variation in Manchester. On the whole, I found the amount of brewing sugar employed in Manchester rather less if anything than in other parts of the country.

Variations in amount of glucose used by different brewers.

1292. Was that dependent on the saccharine matter to be found in the barley?—Not so much on the saccharine matter as upon the other constituents of the barley malt. It is not used with a view to make up the deficiency of the barleys in saccharine, but more to dilute what are found to be the objectionable constituents on certain barleys for the production of light beers.

1293. I suppose, broadly speaking, you can state of your own knowledge that very energetic steps were taken by the brewers in Manchester when once this terrible discovery was made to call in the beer?—They took the most energetic steps it was possible to take, and in this they placed themselves entirely under the direction of Mr. Fletcher Moulton and the Committee. They organised a laboratory for examination, and every barrel of beer brewed in Manchester by members of the association was submitted by sample to the analyst, Dr. Miller, and his assistants, and no beer was allowed to be sent out until it had been passed by him. All the barrels of beer

Precautions taken by brewers.

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which were in the hands of publicans were visited, their numbers ascertained, and when it was known that they had been brewed with Bostock's sugar in any shape or form this label was placed upon them, stating that they were not to be sold until further examined. (*A copy of the label was put in.*) This is a copy of the certificate which was sent out with the brewings when they had been passed by Dr. Miller. (*A copy of the certificate put in.*) And this is a copy of the form of certificate which was put in the public-house windows. (*Certificate put in.*)

of beer.

1294. With regard to the calling in of the beer, I presume that a great quantity of beer was destroyed?—I saw thousands of barrels destroyed myself.

1295. Was there any difficulty in getting the trade to return their beer?—Yes; the publicans thought it a sin to destroy such good beer. They frequently stated that.

1296. And they were prepared to risk the consequences?—I would not go so far as that, but I say that the brewers experienced great difficulty in getting the beer returned.

1297. Could the brewers have taken more energetic steps in that regard—could not they have sent round to such licensed victualler?—They did, and they did more than that when they found there was a difficulty in getting the beer back, and after having insisted upon the label being placed on each cask that was suspected, Mr. Fletcher Moulton drafted a form of letter, which was subsequently sent to all the retailers, stating that they vended such beer at their own risk and peril. After that the beer was returned to the breweries, and it was all destroyed.

1298. Did it begin to come back then?—Yes. Control samples from the breweries were from time to time sent in London to me, and I am in a position to state now that there is no arsenical contamination beyond negligible traces in the beer of Manchester to-day.

1299. Was anything done with regard to the bottled beer that might have been sent out to grocers or wine merchants?—Similar steps were taken, I understand. The measures taken were fully comprehensive in every respect. I may be permitted to add that it required great organisation on the part of the brewers to obtain the recalling of this large quantity of beer and to effect its destruction; and the brewers worked until past midnight many nights to perfect this organisation.

Examination of brewing sugars of other firms.

1300. You mention that Messrs. Drake and Company, the sugar brokers of Mincing Lane, obtained for you samples of brewing sugars and materials?—Yes. When the committee of experts returned to London it was decided that an investigation should at once be made as to the presence of arsenic in all materials used in brewing, and to this end I asked Messrs. Drake and Company, as independent sugar brokers, to obtain for me, in the ordinary way of business, samples current on the market of all the brewing sugars, and this they did through different sources, and they were then submitted to analysis. I have analysed, I think, 118 samples in all, and, with the exception of Bostock's sugars, I found them to be all free from arsenic, with one exception, and in that exception I found a mere negligible trace. Then I asked Messrs. Drake and Company to secure for me specimens of the sugars which had been made prior to the discovery of arsenical poisoning.

1301. What was the date when Messrs. Drake and Company let you have these samples; was it before or after the 30th of November?—After. It would be about the first or second week in December. They were sending them in from day to day. I did not get them all on one day. It was when we returned from Manchester.

Arsenic found in one sample only.

1302. Then these samples were obtained some considerable time after the first alarm about the epidemic?—That is why I say that, having satisfied myself that the samples in current use were pure, I then asked Messrs. Drake to secure for me samples which had been manufactured previous to the epidemic. That they did, and those are recorded in separate analyses. In that case I found the trace of arsenic in one, and in all the others there was no arsenic whatever that I detected.

1303. What about the trace that you found in one case?—It would come within the same category as a trace of arsenic in some of the samples of malt spoken to.

1304. Would it be such a trace as would prove injurious to life?—I could not speak as a medical man to that; it was not a trace that the medical colleagues of the committee would so consider.

1305. Not sufficient for that?—Certainly not. It was very minute.

Precaution by brewers to obtain sugars to obtain arsenic acid.

1306. I believe you are anxious to state something with regard to the guarantees exacted by different manufacturers with regard to the purity of the sulphuric acid employed by them?—We thought it was advisable to inquire how the manufacturers of the various brewing sugars had guaranteed for themselves and the brewers that the sulphuric acid they employed was free from arsenic, and we ascertained that either they used sulphuric acid made from brimstone or sulphuric acid made from pyrites, but so purified that they had a guarantee that it contained no iron, lead, nitrous compounds, or arsenic. I myself inspected several of these forms of guarantee which were given to the manufacturers previous to the outbreak. I then received a letter which was sent to the chairman of the Manchester Brewers' Association, dated the 15th December, 1900, signed by all the makers of brewing sugar in the Kingdom. With your permission I will hand the letter in. It runs as follows:—"The commission appointed by your association in its interim report states that its investigations point to the conclusion that arsenic has been found in certain brewing sugars. In consequence of this announcement, the makers of brewing sugars in the United Kingdom, other than the firm named, have met and discussed the question, and I am authorised in their name to state as follows:—'It is, and always has been, their invariable custom to use arsenic-free acid in the manufacture of sugars. They have never known any other course pursued until the present case. They are ready to permit your commission to verify this statement.' Feeling sure that you will give to this important trade the opportunity,—I remain, yours faithfully (Signed) Richard Garton. P.S.—I subjoin the names of the firms in whose behalf I make the above statement. To the best of my information they include the whole of the trade with the exception of the firm mentioned in the interim report of the commission." Then the signatures of all the makers are appended. Those names, of course, do not include the makers of foreign glucose. There is a very large import into this country of American and German glucose, and I may be, perhaps, permitted to state that any recommendations which the Royal Commission may make in respect of the control of these substances would have to include some method of dealing with the purity of imported as well as home manufactured brewing sugars.

Importation of glucose.

1307. (*Mr. Cosmo Bonsor.*) I believe a few months ago there was a very large importation of American glucose?—There is a very considerable trade in it to-day.

1308. Did you find any sold in Manchester?—Yes, largely. I also found it to be extremely pure. The German product is also quite pure.

1309. You just now spoke of the various samples of sugar which you tested, and in which you only found a small trace?—I only found it in one case.

1310. Could you tell the Commission with regard to that case whether it was one in which imported glucose or home-made glucose had been used?—It was a home-made glucose, but the trace was negligible. I merely mention it because it is only right to give a full account of what one found. But it may be ignored. It is not a case in which one could for a moment consider that it was anything but a negligible quantity as compared with the loaded quantity found in the Bostock sugar.

1311. Have you any idea of the proportion of imported glucose compared with the home-made article?—I could not give you the exact figures, but I could give you figures that would enable you to form an idea. One firm of manufacturers in this country make about 45 per cent. of the total amount used in the country, and another firm make about 25 per cent. of the total quantity used.

1312. (*Professor Thorpe.*) You mean used by brewers?—Yes, by brewers; I am only speaking of the brewers. The other quantities of imported sugar would be very large. There are six other makers of brewing sugars in this country, including Bostock, and they account for the 30 per cent. balance.

1313. Then 70 per cent. is really in the hands of two manufacturers?—Yes.

1314. And the other 30 per cent. is supplied by the remaining manufacturers plus the foreign supply?—Yes.

1315. (*Mr. Cosmo Bonsor.*) Is foreign glucose very largely used in the manufacture of ginger ales and that

class of drink?—I have reason to believe it is largely used.

1316. Is it in Kops ale?—I could not specify any particular make, but in the manufacture of what are called temperance beverages, which include a large variety of preparations, I know that it is considerably employed.

1317. (*Professor Thorpe.*) Both German and American?—I should say both German and American. I would not speak positively as to that, but I think so.

1318. (*Chairman.*) I must ask you a few questions with regard to this very important matter of the test. Although I am very far from an expert in these matters, I must ask you one or two questions which may be supplemented by Dr. Thorpe afterwards. You say that in the initial stage of the inquiry a very severe application was made with regard to test, and it was so stringent that it would frequently not pass a beer brewed exclusively from malt and hops; and you further urge that what really was required in the emergency was a test that would permit the brewers to carry on their trade while at the same time protecting the public. I should like you to explain that statement as far as possible?—At that time we, in common with all other experts, I think, were unaware that malt and other materials used in brewing were apt to contain traces of arsenic or that they did contain them. We advised a very stringent form of what is known as the Reinsch test, which we recommended Dr. Miller to carry out before he passed any of the beer in the Manchester district. When he came to apply that test, he found that he could not pass many beers that were made only from malt and hops, and also beers brewed with admittedly pure brewing sugars. We found that certain indications which analysts not versed in the analysis of beer for arsenic would have taken as indications of arsenic, notably the blackening of the copper in the test, was not due to the presence of arsenic at all, but to certain constituents which might locally arise in the water and in the materials legitimately employed in the manufacture of beer. Therefore we had to modify our test after consultation with the medical authorities, so that we were sure that all beer that went out for consumption would be free, whilst permitting the brewer to carry on his legitimate practice, leaving it to a later period to investigate the question of traces we had discovered, and to deal with them in another manner at a later stage. The test was only intended to be provisional, and it was one which we were assured would adequately protect the public, and we have reason to know that it has done so.

1319. In fact, you dealt with the whole question as a very grave public one, and your chief object was to protect the public in that emergency?—Quite so.

1320. You were rather looking to the future for further investigation?—Yes, with respect to traces.

1321. Which you had never previously suspected?—No.

1322. You further state that, so far as your investigations have gone, you have satisfied yourself that there may be serious indications of arsenic—for instance, that of the blackening of copper, which may be absolutely misleading?—Absolutely so. I should like to show the Commission an instance in point.

1323. The blackening of copper, then, is no certain indication of the presence of arsenic?—No. Here is a blackened copper produced from a beer which does not contain a trace of arsenic. That would be condemned by analysts not previously intimate with the analysis of beer for arsenic. (*Specimens exhibited.*)

1324. That is the original metal?—Yes.

1325. (*Professor Thorpe.*) Would not any process which would reduce any sulphuretted compound give that blackening?—Precisely, and that is what it was caused by. It was not previously known to analysts, who would not be versed in the manufacture of beer.

1326. (*Mr. Cosmo Bonsor.*) Would that be injurious to health?—Not in the least.

1327. (*Professor Thorpe.*) Do you mean to say that anybody would bring a charge against a beer on a test of that character?—I would not go so far as that, but I have seen cases in which the blackened copper has been thought quite sufficient indication until we pointed out that it was no indication whatever in connection with beer.

1328. Do you mean to imply that a public analyst would actually bring a case into a police court on evidence of that character?—I would not like to go so far as that, but I have had cases brought before me in which the analyst had pointed out these blackened coppers as indicating the presence of arsenic in beer. On several occasions I have had such cases, and it was that which led to the necessity of our putting into the report the statement that the blackening was no indication.

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1329. (*Chairman.*) Are you satisfied that you have proved the value of the Reinsch test?—I am quite satisfied that it has protected the public. It was provisionally recommended, but when it came to be worked out more in detail, and one got thoroughly practised in doing hundreds of tests, one found it was much more delicate than one had previously anticipated. Whereas we thought it would protect the public against one part in a million and a half, we now find that, properly applied, it would protect them against one part in three millions, and I am informed by medical authorities that such a trace as one part in three millions, at any rate for the purpose with which we have had to deal with it, is absolutely negligible.

Adoption of Reinsch method had its limitations.

1330. I think there was another distinct case of a large brewery where you had a sample to test, and found it very much contaminated with arsenic?—Yes.

1331. Was this brewery connected with the Manchester Association?—Not in any way whatever.

1332. Was it a Lancashire brewery?—No.

1333. It was distinct altogether?—Yes. They sent me samples of the beer to test for arsenic. I mention it because I applied this Reinsch test, and I at once saw the distinct crystals, and they so much resembled those that I had seen in the case of the Bostock beers, and knowing as I did that this brewery controlled a very large district, I sent them a telegram stating: "Do not on any account send out; report follows." Then I sent them the following letter: "I have very carefully examined the sample of beer you have submitted to me, and regret to inform you that the same is grossly contaminated with arsenic. In my opinion it would be extremely dangerous to allow this beer to go into consumption, and I advise that it be destroyed at once. It is quite as much contaminated as any of the worst samples which led to the grave results in Manchester. I should be interested to know whether you have been brewing with Bostock's sugars. You must please understand that my report is intended to be of a very serious character, and it is my duty to warn you that you will run a very great risk in permitting this beer in any shape or form whatever to go into consumption." Upon receipt of this letter further samples were submitted, representing eight distinct brewings; and on the 14th December I reported: "I regret to have to inform you that each one of these samples contains very notable quantities of arsenic, and that it will be found quite unsafe and even dangerous to send them out. It is my unpleasant duty to have to tell you that, in my opinion, you have no alternative but to destroy these beers. They could never be rendered free from danger." They then gave me the source whence they were obtaining their brewing sugars, and I found it was from an agent of Bostock and Company. My point is that by this test we were able to detect the Bostock sugar in a beer from a remote part of England, and that the test enabled me to telegraph them in terms strong enough to stop them sending out the beer, and to cause it, as I subsequently did, to be destroyed. I had a similar case from a brewery in the Midlands where this same test was applied, and where I again detected what I think I may term Bostock crystals of arsenic.

1334. (*Sir William Church.*) You merely mean by Bostock's crystals of arsenic a large quantity of arsenic?—A particularly large size, which I could demonstrate if wanted. On inquiry I found Bostock's sugar had been used, and the beer was stopped going into consumption. I therefore point to this fact, that the test which the committee devised did adequately protect the public when properly applied.

1335. (*Chairman.*) Have you any suggestion to make in regard to safeguarding the public in the future from a disaster such as this which you have described?—I would wish with permission to defer my suggestions until I present a further set of experiments which I am conducting in conjunction with my colleagues, but I may say this, that obviously steps must be taken to prevent any sulphuric acid made through pyrites being used in the manufacture of sugar unless it is previously certified as absolutely free from arsenic and other injurious substances or ingredients, or the acid must be made from brimstone, in which case no poisonous contamination is to be apprehended. But that again involves very serious considerations because of the possibility, unless some

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particular form of brimstone is employed, of introducing other possible complications. Therefore I would ask that my evidence upon this point may be deferred. But I would point to this, that in any steps which may be taken, or any recommendations that may be made, the question of the imported sugar must not be lost sight of, because it would not either be just nor would it safeguard the public to lay down certain restrictions in respect of the manufacture of our home products and not to exact similar guarantees in respect of imported articles.

1336. (*Sir William Church.*) When first Mr. Groves referred to you did he ask you whether what are called the higher alcohols were represented in the beer or whether there was an undue proportion of them?—He asked me whether they were present in any of them in abnormal amounts.

1337. Have you any information as to the effect of them upon man?—No; I could not speak with authority as to their physiological or their toxic effect.

Brewers' custom to mix their sugars.

1338. I did not quite follow the explanation that you gave of the Manchester brewers using such a mixture of glucose and sugar?—I found to my surprise when I investigated the brewing of the Manchester brewers that they did not only use one manufacture in their breweries.

1339. You say it is to keep up the quality of the manufacture and keep down the price; I do not quite follow that?—I assume that was their reason for using more than one manufacture; but in every brewery I went into I found they were using at least two, and sometimes three, different makes of brewing sugar. They were using, for instance, Bostock's, Garton's, or Manbré's, and an American sugar, and they were mixing them, and I say that that was the reason why this poisoning was not much more widespread than it was. I think the reason they used them was that they kept up the quality of the various makers by letting them all supply a quantity of each make of sugar, and at the same time kept down the price. In that connection may I be permitted to state that I have made an examination of hundreds of invoices of the prices paid for these brewing sugars, and I found that the price paid for Bostock sugar by the Manchester brewers was just as high as that paid to the other makers.

Price of Bostock's sugar.

1340. It was not that part I did not understand?—I should like to be permitted to exhibit these invoices. The price of the glucose was 10s. 6d. per cwt. in the case of the Bostock sugar at the same date as they were paying 10s. 6d. to Manbré's; and I found the same to obtain for invert sugar throughout the various breweries in Manchester. Thus we have established the fact that they were not used for the purposes of economy.

1341. (*Mr. Cosmo Bonsor.*) I take it most of these sugars are sold through travellers?—I think so.

1342. It is a question of the traveller calling on the brewer, and each traveller gets his order in turn, as long as the price and quality are the same?—I think that must be so.

Arsenic in all-malt beer

1343. (*Sir William Church.*) Did Dr. Miller report that he could not pass beers which he knew had been brewed from malt and hops only?—In certain cases they would not pass the first test.

1344. Because they were contaminated with arsenic?—With traces.

1345. These, I suppose, were beers that were brewed by firms which had been using Bostock's materials before?—I should say not in all cases; in fact, I know it was not so in all cases. But in many cases it was found that the best way to get absolute freedom from arsenic was to employ a much larger proportion of brewing sugar than had hitherto been used, and so dilute the negligible trace of arsenic in the malt. The arsenic in the malt is a matter that can be easily dealt with. There is no difficulty in taking the arsenic completely out of malt, and producing a malt that does not contain any arsenic at all. I shall be prepared at a later stage to show the many analyses we have made in connection with that subject and to trace to the very bed rock the reason and origin of the arsenic in traces in malt. But it must not be for a moment assumed that those traces bear any sort of comparison to the arsenic that has been found in these Bostock sugars, and which caused this outbreak.

1346. But still the fact remains that Dr. Miller did find traces of arsenic in this beer? It was not traces of darkening of copper from other substances, but really was arsenic?—It really was traces of arsenic.

1347. Have you formed any opinion in your own mind as to what is a negligible quantity?—I would sooner see none at all, and I think it is quite feasible and practicable for the brewer to brew with malt which contains no arsenic whatever, and I may say that the bulk of beer in the United Kingdom to-day does not contain a trace. It is only when the maltsters employ cheap materials to compete with the taxation of the brewer, the economy they are bound to effect to keep pace with that taxation, that they run into these possibilities; but the malt can be made so that it does not contain a trace of arsenic.

1348. But you would rather not express any opinion yourself as to what quantity of arsenic might be present in beer without being prejudicial to health?—I think, with all respect, that the statements which have been made as to the quantity of arsenic when it deals with traces are most delusive. They are estimates, not determinations. When one finds a mirror such as *that*, which represents 50 grammes of a malt, and then ventures to state how much that corresponds to in a pint by a comparison with similar mirrors, I do not regard it as accurate work at all. (*Specimens shown.*) *This* is 100 times the quantity of one of the Bostock sugars, and by comparing the two you will see the difference.

1349. Are crystals visible by the microscope in both cases?—Not in that case; but I should like to show you some of these specimens. (*Further specimens shown.*) Here are the coppers that I obtained. *Those* coppers would represent the arsenic-free coppers of the materials other than the sulphuric acid, and *that* brewing sugars given to me by Dr. Tattersall. They are free. *That* represents one of the bad Bostock sugars, and *this* another. That grey is very typical. If the sublimate is examined under the microscope the crystals are exceedingly distinct. I would very much like to have the opportunity either of handing these to Dr. Thorpe to exhibit to the Commission under the microscope or of exhibiting them myself, because there is something to be learned here in respect of traces. I find that if you take 50 grammes of a malt, and find a distinct trace, and then put it through this test and get it in the form of a sublimate, there is always a minute crystal, as compared with relatively very large crystals which one gets with the test if there are any notable quantities present, such as in the case of the Bostock sugars.

1350. You spoke almost as if you could identify arsenic from Bostock's sugar, but it is only because of there being a large quantity that you get much larger crystals?—Larger crystals, yes.

FOURTH DAY.

AT WESTMINSTER PALACE HOTEL.

Thursday, 7th March 1901.

PRESENT:

The Right Hon. LORD KELVIN (in the Chair).

The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Mr. COSMO BONSOR.
Professor THORPE.
Dr. WHITELEGGE.

DR. BUCHANAN, *Secretary*.

MR. ALFRED GORDON SALAMON, recalled.

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1351. (*Professor Thorpe.*) You told us that your first communication with Mr. Groves with respect to this catastrophe was in connection with a request from him to examine the beer for the presence of higher alcohols?—Yes.

1352. It would be interesting, I daresay, to the Commission to know precisely what you did in satisfying him as to the absence or presence of the higher alcohols?—I have already stated that I only went a very little way in the investigation. I had very little time in between the request to investigate for the higher alcohols and the visit of Mr. Groves and when he informed me by telegram that the suggestion was of arsenical poisoning; and, therefore, I had not got further than to fractionate. I showed Mr. Groves various fractions which I had made of the alcohols, and I really did not go further.

1353. Did you identify the higher alcohols?—No, I did not; I had not got so far as that. Mr. Groves agreed with the idea that any pernicious influence due to the presence of higher alcohols would have to be abandoned in Manchester, and, therefore, it was unnecessary to proceed further with that phase of the investigation.

1354. Do you know how the idea that higher alcohols had anything to do with the mischief occurred?—I believe it emanated from one of the medical authorities who was investigating the hospital cases. It was a theory advanced to account for the symptoms which had been noticed.

1355. You do not know that there is any connection between neuritis and the higher alcohols, do you?—I do not.

1356. You told us, I think, that you yourself examined certain of the products employed by Messrs. Groves and Whitnall?—I did.

1357. You examined both the glucose and the invert?—Yes, and various other substances submitted to me by them.

1358. Does *this* sample of glucose in any way resemble that which you examined? (*Handing sample to witness.*)—It was similar in appearance, certainly.

1359. Did the invert at all resemble *this*? (*Handing sample to witness.*)—Yes. It was not quite so solid when I had the samples drawn from their brewery; but that, of course, does solidify, as you know, after the sample has been kept.

1360. For all you know, that might be an identical sample with what you examined?—Quite so.

1361. Are those good average commercial samples, so far as you can tell outwardly, of glucose and invert?—Quite; I could not distinguish them from the best samples upon the market.

1362. There is nothing in their appearance to indicate that they contain any deleterious substance?—Nothing whatever.

1363. You said something yesterday about the power which yeast has of secreting arsenic. Have you anything to add to what you then stated on that point?—You will pardon me for suggesting that I do not think I used the word "secreting." I do not know whether the action is connected with the development of yeast, or whether it is a more absorbent action. The yeast in the course of fermentation passes through the whole volume of the fermenting wort, and certainly there can be no doubt whatever that yeast has the power of absorbing considerable quantities of arsenic. I have tested the yeasts from all the breweries in the Manchester Association, and I found that in every case when Bostock's sugar had been employed the yeast was very considerably contaminated with arsenic. I have found from the samples which I have since had that the yeast is practically free from arsenic now. I consider that the yeast played a very considerable part in the removal of a large portion of the contamination, because it reproduces to a very considerable extent in the process of fermentation, and only a very small portion of that reproduced yeast is retained for purposes of subsequent fermentation. Therefore, that which constituted the portion not so employed had removed a corresponding amount of arsenic.

1364. What I should like to get from you, if you have considered the question, is whether you imagine that arsenic had anything to do with what I may call the metabolism of the yeast?—Personally, I do not think there is any evidence to show that arsenic is connected with yeast metabolism. As far as one can judge, there does appear to be evidence pointing to the fact that certain ferments or certain fungi of the type of *penicillia*, and some *mucorini*, do in the process of metabolism assimilate a considerable quantity of arsenic, but I have no evidence of anything similar proved to exist in respect of yeast. The fungi to which those investigations refer are all of the aërobic type as distinguished from the anaërobic, to which yeast belongs, and it would be quite impossible that such fungi should be present in quantity in beer, provided that saleable beer were to be produced.

Combination of arsenic with organic matter of beer.

1365. I think this is a little important, because it may throw light upon what I suppose is a difficulty, and has been a difficulty, in explaining the action of these presumably small quantities of arsenic. I suppose you agree with most people that it is a new development in the toxicology of arsenic that there should be such widespread misery apparently caused by such relatively small quantities of arsenic?—I cannot speak as a toxicologist, but as a chemist it has amazed me.

1366. Of course you are aware that various surmises have been made to account for so small a quantity of arsenic doing such widespread mischief?—Yes.

1367. Some of these surmises had reference to the possible combination of arsenic with substances developed by fermentative changes?—Yes, I have heard that put forward as a theory, but I have seen no evidence in support of the theory up to the present moment. I understand that certain researches are being made upon it, particularly with reference to the possibility of certain of the albumoses in beer combining with arsenic to form possibly a more injurious arsenical compound than

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if it were in the state of arsenious acid, or an arsenite. I understand that such researches are in progress, but I do not know the results. It must evidently be a very prolonged and difficult investigation, and I should imagine that it would take some time before reliable data upon such a head would be forthcoming. I do not think they exist at the present moment in respect of beer or yeast.

1368. Are you able, from your knowledge, to trace the origin of those surmises? Have they been connected with the ascertained fact that certain forms of mucor, aspergillus, and penicillium, to which you have alluded, have the power in contact with arsenical products of generating either hydrogen arsenide, or substances like diethyl arsine?—I believe that was the source of the suggestion. Indeed, it was mentioned to me by Dr. Reynolds. I believe it was an opinion, as you have mentioned, that such fungi would be found in breweries, and I pointed out to him the impossibility of finding them there in connection with beer.

1369. May we gather this from you, that it is your distinct opinion that no form of saccharomyces will give rise to these products?—I have no evidence whatever before me that such is the case, and as far as one is justified in speaking from present knowledge I do not think it is so.

1370. These things—penicillium, mucor—are occasionally to be met with as spores or wild ferments in beer, are they not? I mean the various forms of mucor and other things which have been mentioned?—Yes, they are occasionally to be met with, but in relatively negligible quantities when the beer is good.

1371. Are those ferments which are connected with the diseases of beer likely to form the compounds that the mucor and the penicillium do?—They would come under another class. It would be more in the nature of butyric and lactic ferments; but I have no knowledge that those ferments which give rise to bad beer give rise to these compounds. There are various forms of *sarcina*, for instance, which give rise to very troubled and bad beer, the mycoderma aceti and various other ferments; but I have no knowledge that these have the power of forming the compounds to which you have made allusion.

1372. In the process of fermentation of beer is there any free oxygen in the liquid, conveyed originally from the air?—Yes; one has, in order to conduct a brewing fermentation successfully, to introduce air at certain stages of the fermentation, and that is best done by rousing the fermenting wort. Some introduce the air direct in the bottom of the fermenting vessel. The object of rousing and thus introducing the air is twofold. I am not sure that it is wholly intended to supply oxygen so much as it is to give a means of effectually disengaging the large proportion of the carbonic acid, and that carbonic acid being the excreted product of the fermentation; and the immediate environment of excreted products being inimical to the progressive development of any organism, it is desirable to remove them, and it is done, in the case of carbonic acid, by agitation resulting from the introduction of air; but as to whether or no the oxygen itself plays a part in invigorating the yeast is a question upon which I would not like to speak with dogmatism. In my opinion it does assist, but I would not like to go further than that.

1373. What I want to get from you is, do you think the amount of carbonic acid which is produced in the process of fermentation would eliminate or expel the oxygen from the air introduced. When you analyse the gases expelled from finished beer do they contain oxygen?—I could not answer that question offhand without reference. I do not think they do, but I am not sure.

1374. May I point out to you the significance of my question? If it is alleged that a poisonous substance like diethyl arsine or so-called cacodylic derivative is produced in the fermentative change, I think I need hardly point out to you as a chemist that the immediate effect of free oxygen associated with that would be to oxydise it to diethyl cacodylic acid?—That certainly would be so.

1375. And that substance, strange to say, is a relatively non-poisonous substance?—Yes, that has been proved, I think, by Gautier.

1376. It has been proved two or three times that it is only poisonous in very large amounts. These things require relatively large quantities to be injected sub-cutaneously or given as doses to produce any toxic action?—Now I think I can answer your question more satisfactorily, having understood it better. I think there can be no doubt that such a change as you suggest must necessarily take place, because during the process of fermentation it is usual to move, at any rate in most of the modern systems, the beer from one vessel to another during the process; and not only by means of air introduced as I have explained, but in the process of dropping from one vessel to another, there is a large contact with oxygen, which would presumably act in the manner you have suggested.

1377. Supposing you are told that if you add known quantities of arsenious oxide to a wort and you then put the wort through the fermentative process, and you determine the amount of arsenic in the finished beer, and you found the exact equivalent to the arsenious oxide which you started with, would that in your opinion negative the supposition that any cacodylic compound had been formed?—It would. It must necessarily negative it.

Demand arsenic-free bre materia

1378. You say in your *précis* that in your opinion the best practical method of purifying Manchester beer from traces of arsenic has been to employ an increased quantity of brewing sugar, the purity of which was beyond suspicion. What is it you exactly mean by that?—I mean that when every brewing was tested, and it was discovered that malts and other materials contained hitherto unsuspected traces of arsenic, the Association, acted upon the advice of the expert committee, were so surprised that they would not pass any beer that contained even the trace as developed by this test. They found that the best way to dilute the trace was to bring it outside the limits of the test, strict as it was; so they added these brewing sugars, in which no trace of arsenic could be found. To my own knowledge, that plan was largely adopted.

1379. Yes; but that is not the specific action of the sugar. Any other material from which beer is made might be employed?—Quite so. It was a material which was known to be free from arsenic as against a material which was found in some cases to possess it in traces, and therefore the quantity of added sugar was augmented.

1380. It amounts to nothing more than this, that you go on brewing with pure materials, and by that means you eliminate arsenic?—Yes, absolutely.

1381. There is no specific action in the sugar?—No, I never meant to suggest that.

Import glucose

1382. You drew the attention of the Commission, in case any requirement should be made as to guaranteeing the purity of glucose, to the necessity of extending that guarantee to foreign glucose?—I did.

1383. You drew our attention to the necessity of having provisions made to cover imported glucose as well as home-made glucose or invert?—Yes, as a matter of protection to the public and justice to the brewing industry.

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1384. Quite so. Do you apprehend that there will be any difficulty in securing that guarantee in the case of imported products?—I do not think there would be the slightest difficulty. I have examined all the foreign samples on the market and found them pure. I suggest that if there were to be an examination of all brewing sugars used, and that such examination were to extend to the examination of imported sugars, the guarantee would not suffice, but the sugars would have to be analysed at the port of entry or by the Customs, as, for instance, is done in the case of shipments of wines abroad to those countries where the use of salicylic acid is prohibited. I have frequently samples sent to me to examine for salicylic acid before the wine is sent abroad, because there are certain countries which will not permit such wines to enter if they contain salicylic acid. These examinations are made at the port of entry, and some such course would have to be adopted, provided all brewing sugars were examined and were required to be guaranteed as to purity.

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1385. But would not the same arrangement suffice in the case of the imported glucose as in the case of the home-made glucose, namely, that the vendor should produce a satisfactory warranty or guarantee of purity as a condition of sale?—Personally, I believe it will be found quite sufficiently effective.

1386. Of course, there are large numbers of imported products of which are only sold by analysis?—Yes.

1387. The person vending them produces an analysis showing the character of the article which he offers for sale?—Yes.

1388. And the articles are bought upon that analysis?—Yes.

1389. The same system might be extended to the case of imported glucose?—Yes. I think it would be a sufficiently safe guarantee without being cumbrous—I mean without involving cumbrous machinery in order to ensure its purity.

1390. To your knowledge does the list of firms appended to Mr. Richard Garton's letter comprise all the makers of glucose or invert in Great Britain?—I believe it does. It was so stated to me.

1391. Is much imported glucose used in breweries?—There is a considerable quantity to my knowledge. One particular brand, or I might say two particular brands are largely employed and held in high esteem, and deservedly so.

1392. Where do they come from?—One comes from America and is known by a particular brand name, and the other comes from Germany.

1393. Do you know the origin of those glucoses? What character of starch material are they respectively made from?—I believe the American glucose is wholly made from maize. I could not speak with certainty as to the starch that the German product is made from, but I know it is exceptionally pure as a finished article.

1394. Have you reason to know it is made from potato starch?—I know that potato starch is used in the factory from which the product comes, and the firm make very large quantities of liquid glucose and also potato farina. But I think also they employ other sources of starch. Therefore I am not in a position to state what is the origin of the German glucose. I do know that potatoes are very largely employed in the factory at which this glucose is made.

1395. You are aware of the statement, are you not, of Clouet and Ritter as to the presence of arsenic in glucose?—Yes, I know those statements.

1396. Those were independent statements, were they not?—Clouet and Ritter's were independent.

1397. One is a French chemist, I believe, and the other a German?—Yes.

1398. Those statements had reference, had they not, to potato glucose?—Yes, I believe they did, because at the time those statements were made I do not think that other forms of glucose were known upon the market as commercial articles.

1399. Do you remember the date of the observations made by Clouet and Ritter?—I think I can give them to you. Clouet's publication is dated January, 1878.

1400. And Ritter's?—I do not see the date of Ritter's here. I think you give the date in your dictionary.

1401. No, I do not give the date in my dictionary, but the statement was taken from the abstracts of the Journal of the Chemical Society, in which references to the original papers were given. I believe that date was 1879?—Yes.

1402. I suppose that the fact of the possible contamination of glucose with arsenic was not generally known to English chemists?—Certainly not. We never expected it.

1403. In spite of the circumstance that the abstract in the Journal of the Chemical Society drew attention to the fact?—They drew attention to the fact, but on reference to the investigation of Clouet it will be found to deal with only minute traces.

1404. May I ask whether you have any business connection with any of these firms who make glucose and invert in this country?—I only analyse for them. I have no other connection with them whatever.

1405. Have you long analysed for them?—From time to time they sent me samples.

1406. You yourself never thought it necessary to examine those products for arsenic?—I beg your pardon. I should have said I am consulting chemist to one firm. From time to time I periodically examine their materials. I never thought it necessary to examine for arsenic. It never occurred to me that it was possible it could be there.

1407. Are you sufficiently acquainted with the procedure of these firms to know what character of oil of vitriol they would use?—I have made very serious inquiries. I have seen the guarantees in certain cases which they exacted from the manufacturers of the oil of vitriol, and I find that one may roughly say that either they insisted upon using an acid made from brimstone—in which case the possibility of dangerous arsenical contamination was out of the question—or they insisted upon an acid made from pyrites being purified so that it was free from lead, iron, nitrous compounds, and arsenic, and with such a guarantee the sulphuric acid made from pyrites would, as I have convinced myself, be quite as pure as one made from brimstone. *Mr. A. G. Salamon.* 7 Mar. 1901. Pure acid used in sugar factories other than Bostock's.

1408. (*Chairman.*) Was the guarantee you speak of exacted by the glucose manufacturers?—By the manufacturers of brewing sugars.

1409. Was it usual prior to the recent scare?—Yes.

1410. (*Professor Thorpe.*) How far back have your investigations extended with regard to that point, how much prior to this scare?—Generally I may say that my inquiries amongst manufacturers revealed the fact that they have always insisted upon those conditions being fulfilled.

1411. So they had been aware of the possibility of contamination of oil of vitriol with arsenic?—Fully aware of it.

1412. And taken steps to protect themselves?—Quite so, and taken very stringent steps. And it is only fair to add, that having examined the correspondence in this connection between Messrs. Bostock and Co. and Messrs. Nicholson, I do myself think, whatever may be the result of further investigation, that Messrs. Bostock and Co. were under the impression that they were always employing an acid made from brimstone, and hence that they were sufficiently protected.

1413. But you have informed the Commission that to your knowledge manufacturers have not invariably preferred to use brimstone acid?—No; they do not; it is a mere question of choice, given equal purity. Brimstone acid and its liability to contain arsenic.

1414. Would a manufacturer who used brimstone acid think it unnecessary to test his oil of vitriol?—I should say certainly. He might as a precautionary measure test it from time to time, and probably it would be the right thing to do. I have reason to believe that tests were made by manufacturers, even in the case of brimstone acid.

1415. Is it not within your knowledge that native sulphur not infrequently contains arsenic?—It does, but in minute traces. There was one kind of sulphur which used to come to a considerable extent upon the English market, namely Spanish sulphur. That sulphur is no longer upon the English market.

1416. But it might be?—I do not think there is any possibility of its coming again, but I quite agree that tests should be made as to the purity even of brimstone acid. Then some of the Japanese sulphur does contain arsenic. I happen to be very largely associated with the sulphur industry, and I know that Sicilian brimstone is free, to within a minute trace, of arsenic, and that arsenic is scarcely ever found in it. Then there is the sulphuric acid that may be produced from spent oxide.

1417. You do not know, or do you, that occasionally pockets of arsenious oxide are to be found in deposits of native sulphur in Sicily?—I have heard it said so, but I have had many samples through my hands, and I have tested a good deal of Sicilian sulphur of late for arsenic, but I have not found it. Still, I do admit the possibility of such pockets existing, and I agree with the suggestion that even if brimstone acid be employed, frequent tests should be made as to its freedom from arsenic.

1418. You yourself would not say it is a sufficient guarantee in any demand for sulphuric acid that it should be made from brimstone?—I would not; but I would say one would be reasonably safe in using it. An unforeseen accident might occur and therefore testing would be much safer.

1419. Quite so; and in view of what we now know, you say that testing should be obligatory?—I do most undoubtedly. All acid used by sugar manufacturers should be tested.

1420. I suppose it is a fact that by far the greatest proportion of sulphuric acid made in this country is made from pyrites?—By far the larger proportion.

1421. More than nine-tenths?—I should think it would be quite fair to say that.

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1422. And therefore that fact alone would tend to the use of pyrites-made acid in manufactures generally?—In manufactures other than food stuffs or pharmaceutical preparations I should say that pyrites acid would be almost invariably employed.

Brimstone acid.

1423. But in spite of the fact that even among pharmacists it is known that brimstone acid not infrequently contains arsenic, the pharmacist would not rely upon the mere origin of the sulphuric acid in forming an opinion as to its purity?—No, he would not; he certainly should not.

1424. Have you seen a paper by the late Professor Bloxam upon the occurrence of arsenic in sulphuric acid?—I have seen an abstract of it, I think.

1425. You will perhaps have seen the original paper in the Journal of the Chemical Society some forty years ago, in which Professor Bloxam showed that practically every sample of sulphuric acid made from Sicilian brimstone contained arsenic. Are you aware of that paper?—I have a faint recollection of it; I will look it up.

No objection to use of de-arsenicated pyrites acid.

1426. I presume there is no particular difficulty in getting pyrites-acid freed from arsenic?—I have made inquiries among the manufacturers, and I have closely questioned them, and, knowing the methods that are a rule are adopted, I think there is no difficulty whatever, and the increased cost of such pure acid is very small.

1427. Therefore, what you tell us comes to this: That you see no necessity to restrict the manufacturer to the use of brimstone acid, but you do think it necessary to call upon him to ascertain the purity of the article which he uses, by chemical tests?—If you can effectually guard the purity of the acid delivered into the works for the purpose of manufacturing food stuffs, I say it is possible to make an acid from pyrites which shall be quite as pure as acid made from brimstone, and that in either case a freedom from arsenic can be secured upon a commercial scale.

1428. (*Chairman.*) In the case of sulphuric acid made from pyrites, can the arsenic be removed during the process of manufacture, or is it necessary to adopt a special purifying process?—It is purified by a separate process.

1429. After the manufacture of the acid?—Yes; after a certain stage of the manufacture.

1430. In the English process of making sulphuric acid from pyrites, arsenic will get into the acid, I suppose?—Yes.

1431. That is if there is arsenic in the pyrites?—Yes.

1432. We have been told that in the German method the shape of the flues and the dimensions of the apparatus are different from those in the English process, and that a large part of the arsenic by that means does not get into the acid at all. Have you experience of that?—I know the difficulty that a very noted German firm experienced in dealing with sulphuric acid in connection with a recent invention, and their difficulty consisted in freeing their sulphuric acid from arsenic. Beyond that I could not go.

1433. They did not claim that they could produce it from pyrites direct without arsenic being in it?—I know their attention was directed to the elimination of arsenic from the sulphuric acid, presumedly manufactured by them in Germany, and therefore I should doubt such a statement. But beyond that I could not go; it would be a matter which would require to be investigated.

1434. (*Professor Thorpe.*) Have you much personal knowledge of the manufacture of oil of vitriol?—No, I do not speak as a manufacturer, but I have made inquiries and studied it since this investigation. Otherwise I could not speak as an expert in the manufacture.

Guarantees given by brewing sugar makers to brewers.

1435. Is it within your knowledge that the manufacturers of invert and glucose sugar are now giving warranties of the purity of their articles from the manufacturer?—Yes, they are.

1436. Have they done that voluntarily or has it been demanded from the brewers?—I should think it would be a little of both, but I could not say.

1437. There is no difficulty about the matter, then?—No. I should say that brewers would not now buy brewing sugar which was not guaranteed by the makers. The makers would be quite willing to guarantee it. Except in the unfortunate instance of Messrs. Bostock they are only guaranteeing to deliver what they have previously done.

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1438. You have no knowledge of the particular tests which are employed by the makers of glucose in connection with their guarantees? Have you any knowledge of the tests they use?—The precise tests themselves?

1439. Yes?—No, I have not.

1440. Then, of course, those guarantees may possibly have relation to very different tests?—I am speaking as to guarantees of freedom from arsenic.

1441. Yes, but I ask you whether those guarantees may not have relation to very different tests?—I consider it improbable.

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1442. Do you mean that they are all tested by an uniform method?—I should imagine they were all tested by the Marsh method. I could not say as to how the solution would be prepared, or as to whether they would all adopt a uniform method. I do consider, if I may say so, that it is very desirable the Commission should approve of a method which all makers could adopt, and which if carried out would protect the public.

1443. The object of my question was this: Of course, the tests possibly might be of unequal stringency?—I quite agree.

1444. And your recommendation is that they should be of sufficient and uniform stringency?—I agree.

1445. There would be no difficulty on the part of the glucose manufacturers in conforming to this?—I see none whatever; they all have laboratories and chemists.

1446. Have you considered what precise form the guarantee might take?—I have; but I would ask, with respect, that I may defer my answer to that, because some other questions, notably those connected with the possible presence of selenium, must of necessity be involved in my reply to your question, and one would like to hear a little as to what is alleged with respect to selenium, and then subject the statements which are made to further investigation before replying to that question.

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1447. Quite so; but the object of my question was not exactly to bring out the specific and precise details of the form; it was rather upon what general principle the guarantee should be constructed. I suppose you would agree with me that a mere general warranty or general guarantee is not sufficient in respect of arsenic or with respect to a product turned out by a manufacturer; that is, giving a guarantee dated, we will say, the 1st of January, that would be supposed to cover a whole year? That is what was in my mind?—Certainly not.

1448. You would require a specific guarantee attaching to every delivery of the article?—Certainly, I think it is necessary. I would also point out that I have frequently been asked to give certificates "for freedom from arsenic and other deleterious ingredients," but I have always refused to give such a guarantee, because that would mean an analysis for every conceivable thing which would be deleterious. That, of course, would be impossible.

1449. Your guarantee is intended to relate to particular ingredients in a particular sample?—Exactly, and I think that should be enforced upon the manufacturers of these substances which are destined for food consumption. It might want consideration as to how such a guarantee should be drawn up, but on broad lines I would make that suggestion.

1450. Does this form of guarantee commend itself to you in principle, that the guarantee should state that the sample of invert or glucose designated by particular marks, and referred to in certain invoices, has been tested in accordance with the prescribed method, and has been found to contain no indication of arsenic?—It occurs to me that that would be an excellent guarantee, assuming the prescribed test to be a stringent one such as you suggest.

1451. You agree that it should be prescribed by some central authority?—Quite.

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1452. That guarantee to be signed by the analyst who actually made the chemical test, and countersigned by some responsible person, either the manager or a proper person designated by the manufacturers as evidence that the responsibility for the testing having been done is shared by the manager, or director, as the case may be?—Yes, I think it is highly necessary that the proprietors of the works should certainly take upon themselves the responsibility, because they have

the selection of the chemist, and it is for them to see that they originally employ a competent man, and that he is kept up to the mark in his work, and, therefore, I should certainly think the manufacturer ought to take the responsibility.

1453. That is to say the signatories should be jointly and severally responsible for the character of the certificate?—Personally, I think the responsibility should rest upon the purveyor of the material.

1454. I am only talking of the validity of the certificate for the moment?—It would certainly require the signature of the chemist who made the analysis.

1455. At the present time the certificates you have seen are not exactly in that form?—No, they are not.

1456. In many cases it is a mere general statement of purity, is it?—Yes, a general statement of purity.

1457. That you think is not sufficient?—Having regard to the existing circumstances I do not think it is.

1458. Have you looked for selenium in any materials that have come to you?—Yes, I have. But I am not in a position yet to speak upon the question.

1459. I do not want to press you upon this point if you prefer not to be pressed, but have you made experiments, or have your experiments gone sufficiently far, to say that there is, at all events, any very large quantity of selenium in these products?—I have not attempted a quantitative determination of traces of selenium, and as far as I have gone I have only been able to determine the presence of minute traces in certain substances, but I would not like to say, even to-day, that it is selenium. I have really not gone sufficiently far to speak with any certainty upon the subject, and I would wish to reserve my remarks upon that.

1460. Can you tell the Commission at this stage whether the amount of selenium which you recognise is commensurate with the amount of arsenic that has been found?—Certainly it would not be at all commensurate. I have not found selenium in beer up to the present.

1461. Do you know sufficient of this to be able to tell the Commission what are the relative prices of the various forms of brown oil of vitriol which are commercially saleable, what is crude brown oil of vitriol, say, for instance, of the relative strength of 80 per cent., or any other percentage you like?—I have not those data with me. If my memory serves me aright, Messrs. Bostock and Co. were paying 52s. 6d. a ton, but I would not like to be quite sure of the figures.

1462. Is brimstone acid very much dearer than the other acid?—No, it costs about 2s. 6d. to 3s. more a ton to make.

1463. Is brimstone acid dearer than de-arsenicated oil of vitriol?—The de-arsenicated oil of vitriol made from brimstone would be about 2s. 6d. to 3s. per ton dearer, and the brimstone-made acid would, I suppose, be about 5s. a ton dearer than the crude, what is called B.O.V., brown oil of vitriol.

1464. Then the brimstone acid is the dearest form of the three?—Yes, I think it would be.

1465. Therefore that of itself would incline manufacturers to take the de-arsenicated pyrites acid?—Yes, it would. There is, however, not very much difference in the price when regard is had to the quantities in which the acid is employed in the production of the brewing sugar.

1465. (*Mr. Cosmo Bonsor.*) How many hundredweights of brewing sugar to the ton of acid is produced?—The proportion of acid employed will vary very much. In respect of invert sugar 3 per cent. by weight upon cane sugar would be a fair average maximum. But there is no hard and fast line to be drawn. It depends upon the composition of the sugar to be employed. If the manufacturer employs sugar containing a large proportion of ash by using syrups from which crystals have been extracted, and the ash accumulated in the syrup he would have to employ more acid than he would if he were using crystallised sugar, and therefore it is very difficult to give a fair average. But I think that my figure of 3 per cent. as a maximum would be fair. Then in regard to the production of glucose from starch considerably more would be employed, and that would amount to about 6 per cent. as against 3 per cent., in other words about double. That, again, would be subject to variation dependent upon the steam pressure under which the conversion was made.

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1467. (*Chairman.*) What steam pressures are generally used?—Normally 40 to 50lbs. per square inch.

1468. The object, I suppose, is merely to raise the temperature?—Quite.

Brewers Expert Committee are continuing their inquiry into tests for arsenic.

1469. (*Professor Thorpe.*) I have not yet asked you any questions respecting the methods employed, or respecting the quantitative determinations, because I understand that you wish to defer your evidence upon those points?—I would prefer as regards the quantitative determinations to defer them, because it was arranged by Mr. Fletcher Moulton, as directing our committee, that we should attempt to devise a system for the quantitative determination of arsenic in beer and brewing sugars, just as we did a method for its qualitative determination in beers, which would safeguard the public, and we have had so much to do in the investigation with regard to the traces of arsenic that we have not yet been able to meet to devise a process of making quantitative determinations together. Therefore, I would wish, with respect, to defer my evidence upon that point until such time as we have settled the method.

1470. Are you in this respect acting independently of a committee of chemists who are engaged on the same problem of quantitative determination?—Yes, certainly.

Society of Chemical Industry also investigating tests for arsenic.

1471. You are aware that the Society of Chemical Industry is taking some action in this matter?—I have heard of it quite recently.

1472. Do you associate yourself with that committee in any way?—No. We should be very happy to, probably, but we have not yet associated ourselves with them.

1473. I understand the object of that committee is to bring evidence before this Commission of the varied methods and methods sufficiently stringent which may be employed. Is that so, or is it not?—I believe it is an extremely good idea, because it is very desirable that the manufacturers should be able to speak upon the point, they having to carry out any test which might be devised or recommended.

Arsenic in malt.

1474. (*Chairman.*) With regard to the question of malt as containing arsenic, can you state what is the greatest amount of arsenic contained in samples of malt, and how much that would introduce into a gallon of beer?—The determinations of traces of arsenic in malt are more in the nature of estimations than of accurate determinations. I do not apply these remarks to the determination of arsenic in contaminated beer, because there would be no question as to the public being properly protected by the methods of analysis now practised. But in respect of the analysis for traces of arsenic in malt it would be difficult in my opinion to do more than make a comparative estimation of such traces, and in so doing one would have to take large quantities of material, say, 50 grammes, for an analysis. I might perhaps illustrate it by showing you what I showed yesterday to the Commission from another point of view. (*A set of arsenic mirrors was exhibited.*) In the tube with the mirror is the quantity resulting from the 50 grammes of malt, and fairly represents the trace that would be obtained in malt.

1475. Is that what you would consider a large quantity?—No, I consider that a trace.

1476. This is metallic arsenic, is it?—Yes, this is 100th part of Bostock's sugar. *That* is half a gramme of Bostock's sugar and *this* is 50 grammes of the malt. Now, in order to compare those two in regard to quantitative determination of the arsenic, that would merely be done by a comparison of the relative appearance of the two mirrors, and, therefore, I suggest that that cannot possibly be other than an estimation. That makes it somewhat difficult to say how much arsenic is really in malt, and how much thereby would be introduced into beer. But there can be no doubt that the quantities thus introduced are mere traces, and fall into a totally different category from those in which Bostock's sugar was employed.

1477. Has the malt dust been tested quantitatively for arsenic—I mean the dust proceeding from the brushing and screening of the malt?—I have not tested that quantitatively, but it would not be a difficult thing to do so, because the proportion of dust to malt would be so

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small—that is to say, there is so little dust to such a great mass of malt that if one did collect the dust of the malt which contained a minute trace of arsenic, one would expect to find that dust containing arsenic in considerable quantity, and that, I think, would be certainly capable of accurate determination.

1478. Is it not desirable that such a determination should be made?—Yes, and it shall be done.

No necessity for malt to contain any arsenic.

1479. I mention that because there is some apprehension just now as to positive danger from malt which had been made with fuel which was not free from arsenic in malt kilns?—I shall be able to present at a later stage full details respecting that, and the result of hundreds of analyses that my colleagues and I have been making in connection with the subject. But generally I may be permitted perhaps now to say that the bulk of the malt as sold in this country is free from arsenic, even from minute traces. There is no necessity that any should contain even minute traces, and it merely requires a recommendation, followed by some means of ensuring it being carried out to eliminate one form of fuel used in the malting. Then I think it may be stated with certainty that malt can be produced free from traces of arsenic, even the traces which have been discovered.

Gas coke should be avoided in malting.

1480. Do you consider that the brushing and screening as at present practised on malt, which has acquired some arsenic in the kiln, is sufficient to take the arsenic away and to prevent danger?—From what the medical authorities tell me the arsenic due to malt does not at the present moment constitute a source of danger, but it is quite conceivable that it might, and having made this discovery I do think that the maltsters should use a sort of fuel which would not subject the public to any possibility of danger, and that, as far as our investigation goes at present, is easily to be obtained by not using gas coke.

1481. It would be considerably more expensive, however, I suppose, to use anthracite or other proper fuel?—I do not think so, because coke is only part of the fuel used. I am not aware of malting being conducted where they use wholly coke. It is used to produce a fierce heat at the final stages of malting, and frequently it is mixed with anthracite for that purpose. I do not think it would materially add to the expense of the malting. If the maltster were to employ anthracite and not hurry his malting, but carry it out in a proper manner, it would make a better article. I know that in all well regulated breweries they insist that the malting shall be kilned with anthracite.

Products of combustion pass through malt.

1482. Have you any experience of malting in Scotland with regard to the peat reek flavour in whisky derived from fuel?—It is necessary as regards the flavour of malt for brewing that it should have what the brewers know as a certain amount of "fire" in it, but whether that fiery flavour be due to the empyreumatic fumes or not it would be difficult to say, but I think that is a necessity. We shall, however, be able to convince you that it can be obtained without the slightest risk of arsenical contamination provided that gas coke be not employed.

1483. Do you not think that a red-hot plate under the malt bed with proper arrangements for carrying atmospheric air through the malt would not give the same results as to the fire, and yet keep the malt absolutely away from the fumes of the burning?—I have no doubt that such an arrangement could be carried out, but I would venture to call your attention to the fact that any radical change of that character would involve the outlay of huge capital.

Alteration in system of kilning would mean great expense.

1484. It would mean enormous expenditure?—Yes, enormous expenditure. It could then only be slowly carried out. There is no question that there is room for improvement in the construction of our English malt kilns, and many of our brewers are very much alive to that fact, but to remodel the whole system of kilning would be an extremely important and large undertaking, and certainly would necessitate a great deal of time.

1485. At present you think thorough security may be had by the use of anthracite?—I think so undoubtedly. I hope I shall be able at a later stage to present the result of our experience in that connection, and then your Lordship will be able to judge for yourself.

1486. (*Professor Thorpe.*) Do you think that the line of least resistance, namely, that which is most quickly attainable, will be followed, namely, to look to the fuel?—I do.

1487. And if the fuel is adequately looked to there is no necessity, you think, to reconstruct the arrangements in the malt kilns?—That is my opinion.

1488. (*Mr. Cosmo Bonsor.*) The maltster could give the same class of guarantee as the glucose manufacturer?—Clearly.

1489. That would be a protection to the public?—That would be adequate, I think.

1490. (*Sir William Hart-Dyke.*) You say, speaking from your knowledge, that the only possibility of contamination of malt by arsenic is through the use of a fuel from the fumes of which this result is brought about?—That is my impression.

1491. And also, supposing the Legislature or a Department were to visit with penal consequences the use of fuel which was dangerous as regards the malting processes, that that would produce absolute security to the consumer of beer?—I am not in a position to express an opinion as to penal consequences, but——

1492. Well, we will put that on one side for a moment, and say provided the security were maintained for the future with regard to the use of fuel?—I agree.

Traces of arsenic in hops.

1493. (*Chairman.*) You have spoken of hops as sometimes, though rarely, containing minute traces of arsenic. I think that was in your evidence?—I do not think I actually gave evidence upon it, but I can say that I have found minute traces in hops, and that would be due to the same reason, and possibly due to traces contained in the sulphur. I think that there would be no difficulty in securing absolute freedom even from these traces in respect of hops. I see no more difficulty for the hop-maker than I do for the maltster.

1494. Sulphur is used for colouring the hop leaves, I believe?—It is used, I think, for the purposes of preventing mildew—that is on the pole.

1495. I have heard it said that sulphur fumes have the effect of colouring the hop leaves in a manner which was considered suitable for some particular beer, or some particular qualities?—I could not speak as to that, but I know that the hop grower pays a very considerable price for his sulphur which he does so employ, and he would have no difficulty in getting a guarantee as to the freedom of that sulphur from arsenic; and in respect of his fuel he would certainly be able to take the same precautions as you have suggested in respect of the maltster.

Liability of malt to contain unknown before epidemic.

1496. (*Dr. Whitelegge.*) Was this danger of the introduction of arsenic by malt and hops known to maltsters and brewers before the present epidemic, say, a year ago?—Only as far as the quotations that have been referred to by Professor Thorpe are concerned.

1497. But that was in connection with glucose?—Yes.

1498. I was intending to leave that, and was referring only to malt and hops.—I have never heard of it before this epidemic, and I do not believe it was known. It might, of course, have been reasoned back; it is a question one could have reasoned out, but, as a matter of actual fact, I do not believe the presence of traces of arsenic in malt or hops was ever suspected until this outbreak.

1499. Was it the practice of any brewers to require assurance with each consignment of malt that the drying had been effected by anthracite?—I could not say that.

1500. You are not aware it was the practice of any brewers?—No, but I know it is the practice of brewers to carefully inspect their malt, and from that point of view they would take note of the classes of fuel that was used, and they may have used—I think they have used—this gas coke in ignorance of its possible effects: that is to say, the possibility of introducing small traces of arsenic into malt.

1501. You think that in future some sort of certificate as that which you have discussed with Professor Thorpe in the case of glucose would be right in the case of hops and malt?—Yes, I see no reason why it should not be given, because there would be no difficulty in acting up to that.

Guarantee by brewer hardly required.

1502. If the brewer has guarded himself by a certificate as regards the materials he uses, what assurance do you think it would be proper for him to give to his customers? Would you think a warranty from the brewer was desirable?—Well, warranties always complicate business.

1503. Would you suggest that the consumer should rely upon the precautions which the brewer has taken with regard to materials, and not require any direct assurance from the brewer?—I do not know whether the brewer should be called upon to give a direct assur-

ance, but I feel confident if the suggestions which have been discussed were given effect to, that no other warranty would be necessary, and that the public would be adequately protected. It seems to me that to call for a warranty from all these different purveyors of material, and then to bulk them into a warranty to be handed to the consumer, is complicating the question, from a commercial standpoint, rather too much.

1504. Do you suggest that the brewer should rely upon his warranty, or should himself, through his chemist, examine all the materials supplied to him?—I think he undoubtedly would examine them through his chemist. Brewers in the past have been in the habit of examining their materials for suitability as regards manufacture. They would certainly have examined them for arsenic had they had any suspicion of its possible presence. But now they will assuredly test for themselves, in addition to any guarantees that may be given by the makers.

1505. You think that will continue in future years?—I feel sure of it.

1506. I do not think that it appeared in your evidence, but in the summary you gave us you spoke of a special difficulty in determining the arsenic in sugar. And there is also another point. You speak of the extreme solubility of the arsenic.—With regard to the difficulty of determining arsenic in sugar, that is a misprint on the *précis* of my evidence; it should be in beer, not sugar. I should have alluded to that in my evidence to-day. It must not be thought that I mean by that beers which are the subject of summonses for contaminated beer—I am speaking of these traces.

1507. What is the extremely soluble form in which arsenic is present in brewing sugar?—It is arsenious acid, or an arsenite which I had in my mind when I made that statement.

1508. If I followed you rightly in your answers to Dr. Thorpe, you do not think that there is any probability of the arsenic in any of the ingredients, or in the beer itself, being present in an organic compound?—I do not; not in the for mthat has been suggested, certainly.

1509. Not in that particular form; but, of course, there may be other forms?—I thoroughly endorse the suggestion of Professor Thorpe, if I may be allowed to do so, that if the compound that has been alluded to were originally present, it would certainly be converted, by the action taking place during fermentation, into the most harmless form of arsenic which is known.

1510. But there may be other organic compounds; could you say that the presence of oxygen would render all of them similarly innocuous, assuming them to exist?—I could not make such a statement without studying specifically each suggested combination.

1511. You think it is not probable, but you have no information directly showing the impossibility of the formation of organic compounds?—No; but it appears to me at the moment to be a piece of academic theorising. The suggestion that it is in that form I do not think is supported by evidence.

1512. Assuming the arsenic to enter into organic combination of any kind, would the tests which you are in the habit of employing reveal that arsenic?—I think so; as far as one knows, it would.

1513. I thought you told Dr. Thorpe that if such a combination were formed the arsenic would not be found on analysis in the same quantity as that in which it was introduced?—As arsenious acid, as Professor Thorpe put it to me.

1514. (*Professor Thorpe.*) The question I put was this: If you had introduced a known weight of arsenious oxide into a wort and you then fermented the wort, and after the beer was finished you, by your analytical processes, got back the same amount of arsenious oxide, you would infer that no formation of such an organic compound as diethyl cacodylic acid, or any analogous compound, had been produced?—Quite so. That is, that the arsenious compound had remained intact and unaltered, none of the arsenious body had been removed. If you start with a certain quantity of arsenious compound and you end with it, it is quite obvious that nothing has been converted.

1515. (*Dr. Whitelegge.*) It may be clear to you and to Professor Thorpe, but I am not speaking as a chemist. If you introduce arsenious oxide in the early stage, and you recover arsenious oxide by some process of analysis when the beer is complete, does it follow that it has been arsenious oxide all through; or may not your process of analysis represent it as arsenious oxide, although it may have been in an organic combination?—There is a possibility of that, yes. It would be a remote possibility.

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1516. So finding arsenious oxide would not in itself disprove organic combination?—It is difficult to answer that question, because the suggestion may be quite accurate; but the true answer could only be given after experimenting with definite compounds in such a case. I would not like to make a statement of a broad, general character in respect to compounds which one has not dealt with by way of test.

1517. (*Professor Thorpe.*) What Dr. Whitelegge means, I think, is this. That you might start with arsenious oxide, it might give rise to a product distinct from arsenious oxide, but the analytical treatment which you put it through would eventually get it precipitated as arsenic sulphide, and in an amount equivalent to the arsenious oxide with which you started?—Yes, that it quite conceivable.

1518. But my point, directed to diethyl cacodylic acid alone, was that that would not occur in that particular case. The arsenic which is in the diethyl cacodylic acid is not precipitable by sulphuretted hydrogen in the form of arsenious sulphide; in that respect the arsenic is exactly in the same relation that cyanogen is in the ferro-cyanide of potassium. Cyanide of potassium is a very poisonous substance, but you can convert it into ferro-cyanide, which is a perfectly innocuous substance?—Yes.

1519. (*Dr. Whitelegge.*) What I had in my mind did not refer especially to cacodylic acid?—I suggest that one would need to have definite specimens upon which experiments would have to be made before any statement would be justifiable in respect to their behaviour.

1520. If arsenic were present in organic combination, with cacodylic acid or otherwise, would it give the Reinsch or Marsh test as ordinarily employed?—With respect to cacodyl, I believe there would be a difficulty, but I have not made those experiments, and I therefore would not like to say.

Arsenic in non-Bostock beer only as traces.

1521. You made a number of analyses of beers and the brewing materials used by Lancashire and London firms?—I have had them from firms all over the country.

1522. And outside what one may call the epidemic area you have not found arsenic present?—Except in the two cases to which I referred, where I found that Bostock's sugar had been employed, and then by acting promptly the beer was destroyed, and I believe no trouble resulted. But besides I have found traces of arsenic, I will not say negligible traces, due to malt and other substances, but certainly not what one could regard as poisonous or dangerous quantities.

1523. You are satisfied that no practical mischief could have happened with such beers?—As far as I am informed by the medical authorities as to the quantities that would be injurious I feel quite sure upon that point.

Brewer's Expert Committee's test

1524. I do not think you have given us any evidence as to the test which was formulated by the Expert Committee?—The test is as follows:—"Take 200 cc. of the beer in a porcelain evaporating dish. Raise the liquid to the boiling point and then add 30 cc. of pure concentrated hydrochloric acid. Insert a piece of pure bright copper foil, about a quarter of an inch by half an inch in size, and keep the solution gently boiling for 45 minutes. If at the end of that time the copper remains bright and red, the beer is free from arsenic. If a deposit is obtained on the copper the foil is to be washed successively with water, alcohol, and ether (care being taken that these are pure), dried at a temperature not exceeding 100° C. and subjected to slow sublimation in a thin reduction tube of small section, and not less than 2 inches long, the upper portion of which should be warmed before the sublimation begins. For the purpose of the sublimation a small spirit lamp flame should be used. If any sublimate is obtained, it must be examined under a magnifying power of about 20° diameters. Any sublimate which does not show well-defined octahedral or tetrahedral crystals is not to be considered arsenical. N.B.—It must be borne in mind that the blackening of the copper or a deposit thereon from the preliminary operation does not demonstrate the presence of arsenic in beer. Abundant blackening and deposit may be obtained from the purest beer.

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provisional only.

1525. In what light do you regard that test? Am I right in supposing that it is a provisional test meant to meet an emergency, and meant to eliminate what the Committee regarded as the dangerous varieties of beer?—Precisely. It was not a test which was meant to deal with minute traces, it was a test conceived after consultation with Professor Delepine, Sir Lauder Brunton, Dr. Stevenson, and Dr. Luff, as to a means of preventing beer being sent out to the public, at a moment of crisis, which contained poisonous quantities of arsenic; and by blank tests, which were made by several of us, we proved that that would protect the public by not permitting a beer to pass that had more than one part of arsenious acid in 1½ million parts by weight.

1526. It would protect the public to that extent?—Yes, and we have since found that it is far more sensitive than we thought.

1527. So that the delicacy which at first you found amounted to one-twentieth of a grain per gallon you have since discovered to amount usually to about one-fortieth?—About that, yes.

1528. This test is put forward by the Committee, not as a final standard of what is right or wrong in the matter of beer?—No, not at all; but simply as a provisional test intended to cope with the special difficulty.

Arsenic not uniformly distributed in glucose.

1529. May we assume that if arsenic as introduced into glucose by reason of the sulphuric acid being contaminated, that in one day's make with the same acid we should expect to find arsenic pretty uniformly diffused through that glucose?—I should expect a variation.

1530. A material variation?—Yes, I think I may say I should expect a material variation.

1531. Is it a fact that at every Machester brewery at the present time all beer is examined for arsenic before going out?—I believe it is certainly done even to-day. But Mr. Groves will be able to speak as to that. That is my information, that the testing is still kept up.

1532. Is that practised elsewhere than in the Lancashire districts to your knowledge?—I could not speak as to that, I am receiving many samples of beer to test with regard to purity and freedom from arsenic, and I assume others are doing the same, and that all brewers are on the alert for arsenic. In fact that I know.

No arsenic in casks which contained arsenical beer.

1533. You told us about the examination of the casks, and said you satisfied yourself that the casks had been thoroughly purified from any traces of arsenic. Were those casks specially treated in any way, enamelled, for instance?—Some of them that I tested were enamelled with a preparation known as Crawford's enamel, and I scraped the enamel and found that free. But other casks which I took in other breweries were not enamelled. It is not a uniform practice to enamel casks, and I found the wooden scrapings in other cases were quite free from arsenic. No source of danger remains there, I feel confident.

1534. And the methods of cleansing adopted in the brewery you referred to were adopted in breweries generally?—Yes, the cleansing of casks is necessarily efficient in breweries if the beer is to remain in good condition, and I feel sure after my experiments in that direction that there is no danger in respect of the cask plant. All other plant is periodically cleaned, and also every day after use.

Mr. A. Salom

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Possible effect of sulphur rived fr hops on arsenic brewing wort.

1535. (*Professor Thorpe.*) There is one question further. The sulphur which may be in hops may be introduced in two ways, it may be dusted over as you state to prevent mildew when on the poles, or small quantities of sulphur may be on them in the kilning?—Yes.

1536. Suppose you introduce, hops containing this adherent sulphur into a wort which contained dissolved arsenious oxide, and the whole boiled together, would that not tend to the formation of sulphide of arsenic?—I should think it would.

1537. You know when you boil flowers of sulphur with water small quantities of sulphuretted hydrogen are formed?—Yes.

1538. The arsenic sulphide would be the so-called colloidal stage; and when boiled would be precipitated?—Yes.

1539. And the yeast would tend to collect it?—Yes.

1540. That may be the origin of a quantity of arsenic precipitated on the yeast?—Yes, possibly I think it is worth following up the suggestion, although the amount of sulphur I have found is very small.

1541. It is as sulphide formed by the action of sulphur on arsenious oxide obtained from the glucose?—That may be worth following up, and I think it is an extremely valuable suggestion. It may account for the way the sulphur gets into the yeast.

1542. What strikes one is the extraordinarily fortuitous method in which the yeast seems to pick up arsenic?—Yes.

1543. May not that be explicable on account of hops being sometimes treated with sulphur and sometimes not, and so depend on the relative amount of sulphur which might be on the hops?—Yes.

1544. (*Sir William Hart-Dyke.*) Are you aware that the sulphur put upon hops is applied to the hops on the poles as the cleansing process?—That is what Professor Thorpe refers to.

1545. But there are two processes; in one, the sulphur is applied to the hops in growth, whereas this is done during a dusting process?—I have seen it done.

1546. Is it not the fact that hops after this dusting process are subject to rain storms, and there is this constant cleansing going on?—Professor Thorpe is only referring to minute quantities; it is not large quantities. There is the possibility that any which has been washed away in the manner you suggest may act in the manner suggested by Professor Thorpe.

1547. Surely it suggests itself to you as a practical man that this being applied to a plant which is in growth, especially in a climate such as ours, with the wind and the weather, it is scarcely possible for any appreciable quantity to remain on?—We are not dealing with appreciable quantities. Following the suggestion of Professor Thorpe, we are only dealing with traces. The hypothesis is concerned with the possibility of the minutest quantities.

1548. (*Professor Thorpe.*) I might, perhaps, remind my colleagues that sulphur is extremely difficult to remove, even when it is wetted. If you dust it on to the plant, you may afterwards wet it as much as you like, but you will not succeed in getting it all away?—That is so.

Mr. James Grimble Groves, M.P., called; and Examined.

Mr. J. G. Groves, M.P.

1549. (*Chairman.*) I believe you are connected with a firm of brewers in Manchester?—I am Chairman and Managing Director of Messrs. Groves and Whitnall, Limited, carrying on business at Regent Road Brewery, Salford, and Alexandra Brewery, Hulme, Manchester. The business of the latter brewery we purchased last year from the executors of the late James Cronshaw. The scope of our business is principally confined to Salford and Manchester, and our output is considerably the largest in those two towns.

1550. When did you first become acquainted with the fact that suspicions were directed towards the purity of beer in the neighbourhood of Manchester?—Until the month of November last year I had no reason whatever to doubt the purity of the beer that my company was supplying. We have a large number of tied houses, and the beer supplied by us to these houses is identically the same as the beer supplied to free houses—there is absolutely no difference in quality.

Mr. Groves

Arseni beer at Groves Whitn brewe action the fir

1551. I understand you wish to give us a chronological account of the action taken by your brewery with reference to the discovery of arsenic in beer in your district?—On November 12th Dr. Cran, one of the district medical officers of Salford, called on me with reference to the amount of sickness in his district. He said that as one of the district medical officers his attention had been called to the increasing number of cases of alcoholic neuritis, as he then described it. "The sickness was alarming, and there were many deaths traceable to it." He came to me because he was in the particular district of Salford in which our brewery is situated, and I had an added interest from the fact that I represent that par-

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ticular division in Parliament. He considered that the illness was principally localised amongst the drinkers of beer, and his theory was that it was due to some of the forms of the higher alcohols which may be referred to as fusel oil. I suggested that this was rather more indicative of spirit drinking than beer drinking, but he replied that the evidence very strongly pointed to beer drinkers, and not spirit drinkers, although it might be assisted by the consumption of spirits. On November 15th I gave instructions for samples to be taken of the principal beers sold in the district, including our own, for the purpose of testing the soundness of the theory advanced. 24 samples were taken, that is, 12 in duplicate. On November 16th I forwarded the samples, marked A to L, to Mr. Gordon Salamon, of London, for investigation, informing him of the theory raised. I believe the analysis for higher alcohols is a tedious and difficult process. In the afternoon of this day, Dr. Tattersall, Medical Officer of Health for Salford, called on me with reference to the same subject, he having previously seen Dr. Cran. He expressed the same views, and held the same theory as to the cause of the sickness. I told him he was free to examine our brewery, and take samples of anything he liked, including our beers and all the materials used in connection with our business. I offered to assist in every possible way to get at the bottom of the mystery. Shortly afterwards he obtained from us various samples, including sugars. On November 21st Dr. Tattersall called on me again, and for the first time suggested that arsenic might be present, being conveyed into the beer through the hops. Up to this time it had not occurred to me in the remotest possible degree that arsenic might be found in beer. Dr. Tattersall also stated that the illness was clearly traceable to the beers of a large number of brewers, including ours. I wired to Mr. Gordon Salamon with regard to the samples sent him: "Try for arsenic." In consequence of the suggestion made by Dr. Tattersall that the arsenic might be conveyed through the hops, I immediately gave instructions for all the hops we used to be analysed; and Mr. Stone, our chief brewer, conducted the analysis the following day, but found no arsenic in them. Mr. Stone is a Fellow of the Chemical Society, and a practical brewer of long experience. We have a well equipped laboratory for the purpose of examining the materials used, in which, up to that time, we never dreamt of looking for arsenic. On November 22nd I travelled up to London, and had an interview with Mr. Salamon the same day. When I arrived, he had only had time to test one sample, which I afterwards found to be one of our own beers, and in this he found no arsenic. I might also say that he had conducted experiments up to a certain stage in following out the first theory raised by Dr. Tattersall and Dr. Cran with regard to higher alcohols; but when I informed him of the arsenic theory he stopped those investigations. We had a long consultation, and finally came to the conclusion that the matter was exceedingly serious, and, if Dr. Tattersall was correct, an exceedingly widespread thing. It was not a matter for myself, as an individual, to investigate any further alone, but one which concerned the whole trade, Dr. Tattersall having informed me that it was not localised to any particular beer, but extended to a large number of cases in his district—that is to say, it was traceable to a very large number of breweries. Mr. Salamon agreed with me that the brewers ought to spare no expense or trouble to sift the matter to the bottom, and render all possible assistance to the authorities; that we should secure the best legal and expert advice; and, with his approval, I decided to recommend that the brewers should engage Mr. Fletcher Moulton, K.C., M.P., as counsel, and himself as analyst. We also discussed the names of several medical and scientific experts to form an advisory committee. I returned to Manchester the same day, and wired from London, just before leaving Euston, to several Manchester brewers, and telephoned to others the following morning, November 23rd, and arranged for the Chairman of the Manchester Brewers' Central Association to call a special meeting the same day. On November 23rd, at 12.30, Dr. Kelynack called on me. He had received through Dr. Forsyth, who is the medical officer to our Brewery Men's Sick Club, certain samples of materials used in our brewery, Dr. Forsyth having previously asked from me and obtained permission to take them. Dr. Kelynack informed me that he had traced the arsenic, not to hops, but to invert sugar—in a sample procured from our brewery through Dr. Forsyth. We purchased the invert sugar from Messrs. Bostock and Co., of Liverpool. On hearing Dr. Kelynack's statement, I at once ordered that Bostock's invert should be discontinued, and not an ounce has been used since. That was following out the third suggestion of the cause of illness produced by the beer, and again I at once took action on the suggestion. We afterwards returned the balance of stock to Messrs. Bostock, keeping a cask of invert and a bag of glucose as samples for reference. Dr. Tattersall called within a few minutes of Dr. Kelynack, and he had discovered arsenic in the glucose also, I believe. I gave him the name of the manufacturer, and he said he would see Bostock's at once. Mr. Stone, our chief brewer, the same afternoon (November 23rd) conducted experiments, and found varying traces of arsenic in both Bostock's invert and glucose. Some was badly contaminated, other samples only very slightly. The only two other sugars we used were found to be free. On the same date a meeting of the Manchester Brewers' Central Association was held at three o'clock. I laid before this specially summoned meeting the result of my investigations; and a sub-committee was appointed, consisting of the Chairman and representatives of six breweries of the district. A resolution was passed thanking me for my prompt action, and I was authorised to wire to Mr. Gordon Salamon engaging his services as analyst, and Mr. Fletcher Moulton as counsel. After the meeting I called upon Dr. Miller, Ph.D., F.I.C., F.C.S., and engaged him to examine all our beers in stock, as well as brewing materials, and all brews before delivery. Being put on the track, we did not, from that moment, send any beer out at all that was not analysed and certified by him. This has been continued up to date. On November 24th Dr. Miller found traces of arsenic in some of the samples of beer submitted to him, whereupon we suspended delivery immediately. All the beer in stock at our breweries was analysed by him, and that which was found to be contaminated we destroyed in the presence of the Excise officers. We have not sent out any since without the brews being analysed and certified by Dr. Miller, as previously stated. We also took every precaution to stop the sale of the beer that was in the hands of our customers until we had been able to have samples analysed. The beer in customers' hands of all brews that were not certified free from arsenic we either turned into the sewers or brought back to the brewery to be destroyed. Altogether, the contents of many thousands of barrels were destroyed, the value of the beer and stout thus dealt with being not less than £15,000. We also took every precaution with regard to having the brewery plant thoroughly purified and examined to see that there was no remaining contamination. Dr. Salamon has examined our plant, and taken shavings from the insides of our casks, which after analyses he reported to be free from any trace of arsenic. On November 25th I met Mr. Salamon at Mr. Fletcher Moulton's house, together with Mr. Weld Blundell (Vice-Chairman of the Manchester Brewers' Central Association), who lives in London. After a long discussion of the matter, it was decided that we should recommend the appointment of an expert committee to advise the brewers, and assist the authorities in the investigations, consisting of Sir Thomas Lauder Brunton, Dr. Luff, Dr. Stevenson, Mr. Fletcher Moulton, K.C., M.P., and Mr. Gordon Salamon. Dr. Samuel Buckley, of Manchester, and Mr. C. P. McKeand, Barrister-at-Law, were added later. I returned to Manchester at 10 o'clock the following morning. On November 26th a meeting of the Special Sub-Committee of the Manchester Brewers' Central Association was held in the afternoon, at which my action was approved, and the committee of experts appointed. On and from November 26th a copy certificate of purity has been attached to each barrel of beer and stout sent out from our breweries, all brews having since then been analysed by Dr. Miller. At a meeting of the Sub-Committee on November 27th I submitted a copy of the certificate* that we were attaching to each barrel sent out, and its form was approved and recommended for general adoption. On November 28th Dr. Luff and Mr. Gordon Salamon came to Manchester and remained until the 30th. They were joined by Sir Lauder Brunton and Dr. Stevenson on the 29th, and the Brewers sub-committee sat daily to confer with them. The expert committee have made many visits to Manchester, and the

Mr. J. G. Groves, M.P.
7 Mar. 1901.

Destruction of contaminated beer.

Testing of new beer.

* "I certify the purity of the brew of beer from which this cask is filled."—(Signed) A. K. Miller, Ph.D., F.I.C., F.C.S., the Laboratory, Withy Grove.

"Groves and Whitnall, Limited."

Mr. J. G. Groves, M.P.

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Brewers' sub-committee have been in constant communication since.

1552. Did your brewery take any further steps to recall contaminated beer, and replace it by beer which was free from arsenic?—As to further action taken at the breweries of Groves and Whitnall, Limited, on November 27th we issued a circular* to all our customers, asking them to cease selling (or using) any beer in stock until further examined. Our travellers also immediately commenced to visit customers with lists of certified brews. Those which were found to be right had a certificate of purity attached to the casks. All others, pending results of further analyses, had a red label affixed—"Not to be used till further examined." On this day some 20 travellers and clerks were sent out to expedite the above work, which was followed up from day to day; and as quickly as possible stocks were replaced by certified beer, and the old stock destroyed on the premises or removed and run into the sewers at the brewery, as previously explained. Many of our houses had to close until stocks were replaced. Some time was occupied in completing the removal and destruction of so large a quantity of beer. In view of this, we issued a second notice† to all our customers on December 1st; and on December 12th, with a view to ascertaining if we had got rid of all contaminated beer, or what quantity, if any, there still remained in customers' cellars on which had been placed the embargo label "Not to be sold," we sent out a further circular.‡ When I brought the matter before the Manchester Brewers' Central Association, they agreed to recommend to their members' action on the same lines that my company had adopted at our breweries. The Association called meetings and issued circulars advising members to follow out what we had done.

1553. Then we may take it that your firm has throughout taken the initiative in this matter, and the other Manchester brewers have followed what you have done?—I think that may fairly be taken as correct. There is no doubt about it.

1553a. You have, no doubt, rendered all the brewers who acted so a great service?—I hope so. It has been very much to our own detriment, but I hope it has been of permanent service.

Use of Bostock sugars in this brewery.

1554. Can you tell us to what extent Bostock's sugar was used in your brewery?—I may say that Bostock's is the only sugar in which we have discovered arsenic. For some time previous to August, 1900, we had not used Bostock's glucose, but that of other manufacturers. Garton, Hill and Co., of Battersea, with whom we were then dealing, being very busy, asked us to suspend our orders, and we then, to oblige them, commenced to take Bostock's, resuming with Garton's about the middle of November, just before the discovery of arsenic in Bostock's goods. The price of the three makes of "glucose" we had used was absolutely the same. The "invert" sugar (Bostock's) was dearer than glucose by over £4 per ton. This was only used as priming for the single X beer; that is to say, we used the dearest material in the cheapest beer. I think that during the year 1900 our total consumption of Bostock's glucose, as compared with other glucoses, was 8 per cent. of the total; but, unfortunately, to oblige Garton, Hill and Co., we used what would otherwise have been our consumption for the whole year in the two or three months between August and November. Had it not been for that we should have been entirely out of this scare, except as to the question of Bostock's invert, which we were not using at the time we commenced. The percentage of Bostock's as compared with our total consumption is 8 per cent. of the whole during the year, and that was used during the time I have mentioned.

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1555. You have spoken of three makers of glucose—Bostock's, and Garton, Hill and Co.—who is the other maker?—The third glucose is called "Climax." It is a very well known sugar, and it was referred to by Mr. Gordon Salamon this morning.

1556. Is "Climax" the name of the factory?—No, the name of the brand.

1557. Who are the makers of that brand?—It is imported from America. It is a high-class sugar, and always stood very well in the market. It has been analysed by us and by every other maker, and I believe has been found to be perfectly pure.

American glucose al u-ed.

1558. Was it glucose or invert sugar?—It was glucose.

1559. Was the glucose that you used in browing from August to November Bostock's?—Not solely; from August to November we were using both "Climax" and Bostock's glucose. We should not have been using any of Bostock's at all had it not been to oblige Garton, Hill and Co. To oblige Garton, Hill and Co., who were very busy, we turned to Bostock, and then we got Bostock's glucose in some of our beers.

Priming.

1560. You were priming with Bostock's invert. How long had you been using that?—We were priming one quality of beer only out of about six. We used priming only in one beer; and therefore we only used Bostock's invert in one beer; all the other beers would have been free.

1561. How long have you been using Bostock's invert for priming beer?—I should say for four or five years.

1562. And have you continued to use it?—Yes, up to the time of this discovery we had used it continuously.

1563. Can you tell us what weight of invert sugar would be added to a gallon of beer as priming?—I cannot tell you that exactly; but I can tell you how much of the solution we add. We follow the Excise regulations, and add half a gallon of solution made from the invert sugar, the specific gravity of which is laid down by the Excise at 1150. That is added to the beer after it is brewed. To 35½ gallons we add half a gallon of such priming, making 36 gallons.

1564. Was the priming always invert sugar, or invert sugar and glucose indiscriminately?—It was a solution made from invert sugar only.

(*Professor Thorpe.*) I can supply the information, if it is wished, as to how much actual weight of invert sugar was used in the priming. It was 1 9-10th lbs. of invert sugar per barrel.

(*Chairman.*) Of this particular priming?

(*Professor Thorpe.*) The priming that Mr. Groves says has a specific gravity of 1150°.

(*Witness.*) I was going to say from 1½lbs. to 2lbs.

1565. (*Chairman.*) Since discarding Bostock's sugar, what other action have you taken?—From the time of our attention being called to the matter, we have required certificates of purity to be furnished to us of all materials used in brewing, and we have conducted careful and minute analyses ourselves, and submitted samples of everything to Dr. Miller, and also many to Mr. Estcourt, the public analyst for the City of Manchester.

1566. Is a private analyst employed by you?—Dr. Miller is the analyst I have referred to, and Mr. Estcourt is the public analyst. We employed him privately as a further precaution.

Brewery ples sen Public Analyst

1567. Has the question of the possibility of malt being contaminated with arsenic ever been brought to your

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* "Our customers are aware that every cask of beer that now leaves our brewery has a certificate of purity attached. We must, however, ask them, under no conditions, to sell any beer they now hold in stock, which, although it probably may be perfectly pure, has not yet been certified, until we are able to attach the necessary certificate to each cask, and we are taking immediate steps to enable us to do this. We are adopting prompt measures to analyse every brew in customers' cellars, and hope to be quickly able to certify the purity of same.

"Groves and Whitnall, Limited."

† "It will of necessity take us a considerable time to fetch back from our houses the stock of uncertified beer which was there on Tuesday last, and which by our letter of that date we directed should on no account be sold. We, therefore, think it prudent to repeat the direction we then gave, and to point out that we shall regard it as a serious breach of duty on the part of anyone who permits any of that beer to be used or sold under any circumstances whatever, and further, that whoever does so will incur a grave personal risk.

"Groves and Whitnall, Limited."

‡ "We shall be greatly obliged if you will state on the enclosed post-card, by return post, the quantity and qualities of beer you may still have in your cellars upon which we have placed the embargo label "Not to be sold." If your cellars are all clear, i.e., that the ale has either been returned or run down the drains in your cellars, please say so. It is imperative we should have this reply by return of post. Please state address in full when replying.

"Groves and Whitnall, Limited."

notice?—Early in the month of December Mr. Estcourt publicly reported traces of arsenic in malt he had examined. This caused us to submit our samples to him and to Dr. Miller. From that time we have discarded doubtful samples, and brewed only from those certified safe. We have found that malts cured with ordinary gas coke are generally contaminated, and those from anthracite coal were free, or practically so. Brushing and polishing the malt causes a great improvement, and is a necessary safeguard.

1568. Is it a necessary safeguard if anthracite is used?—You may say that it is an additional safeguard, but in the case of malt not kilned entirely with anthracite coal it should be an absolute safeguard, because some malts are kilned with anthracite up to a certain point, and coke is used afterwards, or in conjunction with anthracite. We require this to be done with all our malts, and insist upon a personal guarantee of purity from the maltsters with each separate consignment. We insisted upon every invoice being separately and specifically guaranteed.

1569. (*Dr. Whitelegge.*) Guaranteed as what?—As free from arsenic.

1570. (*Chairman.*) Do they mean that no arsenic can be detected in a pound of malt?—Yes, by analysis. They guarantee by analysis. The malt was proved to be free from arsenic.

1571. So that in a pound of malt no arsenic whatever can be detected. Do they guarantee that?—It has to be passed free. It has to pass the analysis free from arsenic. That is the condition of the guarantee.

1572. How much is a consignment of malt, and can an analyst by analysing a single sample tell whether the whole of the consignment is equally safe?—That opens up rather a wide field. I am bound to say, in justice to the maltster that it is quite possible. The fumes which convey the arsenic might impinge upon a certain part of the kiln, and not upon other parts of the kiln; but we take a large number of samples from, say, a consignment of 100 or 200 quarters; we take a large number of samples from various numbers of sacks, mix them all together, and take an average sample out of this total. We have gone to immense pains in the matter, and we have spared ourselves no trouble. I think that is the fairest way of doing it. If that sample passes through, we consider it is a fair indication that the whole lot is free.

1573. When did you think the danger ceased so far as your beer is concerned?—So far as sugar is concerned, in my opinion the danger to the whole trade ceased from the time that the mischief was located to Bostock's materials. In our case it has ceased from the 23rd of November—that is, from the date it was brought to our knowledge.

1574. (*Sir William Hart-Dyke.*) You would have no hesitation, with proper safeguards as regards analyses, in using sugar, either invert sugar or glucose, provided it had not come from Bostock's?—Quite so. We have found no arsenic or trace of arsenic in any sugar but Bostock's. If I wanted to be quite sure that I had an absolutely free material, I should unhesitatingly select sugar as being a free material.

1575. Then you have no doubt whatever that the whole of this mischief has been caused through the medium of this material sold by Bostock as passing through Bostock's hands?—So far as my own knowledge goes, I should say unhesitatingly that the sickness and deaths had certainly been due entirely to Bostock's sugar. As to the smallest trace which may be found in malt, I am not able to say whether it might have caused any damage. I should say not. I should say that traces from malt would not be likely to be detrimental to public health except where there was gross carelessness.

1576. I think you said that the action which you have been taking in this emergency has been very detrimental to your own interest?—I mean in this way. Our name got associated with the "arsenic scare," to use a local expression, at a very early stage, and the public, no doubt, at the first stage jumped to the conclusion that ours was the only beer contaminated. It takes a long time to eradicate a misconception of that kind. It is in that way that I think we suffered considerably more than we have deserved.

1577. You would rather that it had been spread over a larger surface?—The blame has not been spread as it ought to be.

1578. You have been going through a very grave anxiety in addition to loss owing to this crisis?—Yes.

1579. I believe you have applied your utmost energy during all these anxious weeks to secure the consumer to the best of your ability?—Yes, most certainly; I have not spared anything. *Mr. J. G. Groves, M.P.* 7 Mar. 1901.

1580. In answer to the Chairman, I think you indicated certain safeguards for the safety of the consumer in the future. Did you mention any safeguards with regard to the immediate crisis through which we have been passing which you would like to indicate for the future?—My first anxiety was to get over the immediate crisis and to stop the mischief, which was no doubt very widespread. Having done that—and I think we have largely done it by discovering the source of the mischief—I think the results of the investigation have opened our eyes and the eyes of the whole scientific world to facts which were not previously within our knowledge. Those facts having been made public and brought to our knowledge, I think we ought to take every possible lesson that can be gained from those crises, and apply it to our manufactures in the future. Certainly, as far as I am concerned, we shall continue to use the safeguards we are now using, for fear of any possible relapse, although I do not doubt, now that everyone's attention has been called to the possibility of arsenic contamination, that that possibility will become less and less as time goes on, if it has not already disappeared. Precautions as regards arsenic will be continued.

1581. You have given us the form of certificate which has been in use since the outbreak occurred: "I certify the purity of the brew of beer from which this cask is filled." That is signed by Dr. Miller. Is that from your own laboratory?—From Dr. Miller's laboratory. I may say that in addition to sending these samples to Dr. Miller, we test everything now for arsenic, especially raw material. At every stage of the process, right through, Dr. Miller takes a sample. He takes samples, and he certifies these samples; but we take additional precautions ourselves. Each brew now tested.

1582. (*Mr. Cosmo Bonsor.*) Where are the samples collected?—At the various stages of the brewing. Dr. Miller gets them at every stage—as soon as the beer is run down into the fermenting vessel, and before the yeast is added to it. If there is any contamination, it will be worse then than it would be probably at a later stage. He takes the samples at the same time as the Inland Revenue officer does.

1583. (*Sir William Hart-Dyke.*) I suppose at the finish another sample is taken?—We take samples ourselves right through the brew. The sample we give to Dr. Miller is at the worst stage, the most likely stage in which anything would be found.

1584. Are you content to argue from that that there is security so far as the finished article is concerned, or do you take another sample when the beer is fit for drinking?—We take a sample when the beer is ready to rack into the cask—at the finish of its fermentation.

1585. (*Professor Thorpe.*) Dr. Miller's certificate has nothing to do with that, has it?—We consider that if we get Dr. Miller's safeguard at the early stage, we can safely trust to our own samples at a later stage, when there is much less liability to contamination.

1586. (*Mr. Cosmo Bonsor.*) After Mr. Miller's sample is taken, you add the priming?—Yes, in the racking square.

1587. That is the only addition you make?—Yes. The priming is made from sugar which has previously been passed as absolutely pure.

1588. (*Sir William Hart-Dyke.*) Although we may be all anxious, and Parliament may be anxious, not to interfere with any trade such as the brewing trade, yet after such a grave disaster as has happened, affecting human life to such a great extent, you must expect that some very strong guarantee must be afforded with regard to the future, must you not?—Most certainly.

1589. Have you anything to suggest in the shape of such a guarantee beyond the certificate of purity, a copy of which I have just read to you—such a guarantee of purity, I suppose, resting on the basis of other guarantees given to you respecting each of these class materials which you have employed; is that running through your mind?—Yes.

1590. Will you tell the Commission the process you have in your mind as regards some guarantee for the future? In the case of maltsters, for instance, would you insist on a personal guarantee with regard to the purity of the malt?—I have no particular scheme in my mind except such as may be based upon the evi-

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dence I have given, and upon the precautions which we have adopted. If Parliament were to lay down, or the Commission were to recommend, that we should continue for all time to attach some such certificate as this, or even the modified form "Certified pure," or even if Parliament or the Commission laid down that no certificate at all was necessary, I think that all brewers would take precautions in their own breweries and in the purchase of materials which would absolutely prevent any possibility of a recurrence of the mischief from this cause.

1591. That may be so; but the trade, of course, will be very anxious now as regards security after the crisis through which they have passed?—Precisely.

1592. Would there not be a general feeling, when that anxiety has gradually worn off, that there might be a period of carelessness, when a disaster might occur again, and that, therefore, something more than the efforts we have suggested might have to be resorted to?—I think in the future no brewer would be able to shelter himself under an excuse either of carelessness or want of knowledge. As far as want of knowledge goes, I consider the whole brewing trade has had no knowledge at all or any possible suggestion of this danger. I think that will not at all apply to the future, and that even if no guarantees were exacted, every brewer for his own protection, and for the protection of the public, will exercise, and continue to exercise, precautions exactly as they are doing now.

1593. You think, then, in fact, that no brewer in the future would ever think of using what might be a doubtful material?—Quite so.

1594. I apprehend you mean a material which had not been thoroughly tested by accurate analysis?—The materials of which he is not absolutely sure.

1595. As tested by accurate analysis?—Yes.

1596. Carried out by himself or guaranteed by the firm who supplied it?—I should say both.

Illness among brewery hands.

1597. (*Sir William Church.*) Had you been aware of any illness among your employees before Dr. Cran spoke to you?—I had already seen Dr. Forsyth, our club doctor (I mentioned his name as having obtained samples) two or three weeks before this date; not that I had any idea in my own mind, but I had heard a rumour in the place. When I came to look through our list of men, I found several of them were off, apparently more than the average, with a form of influenza. I called upon Dr. Forsyth to ask him if he considered this was due to any special cause. It never entered my head for a moment that it was due to beer.

1598. But still there were a larger number of your employees off duty than the average?—Yes.

1599. Did he mention to you what their symptoms were other than saying he thought they might have influenza?—No; he said he thought they had been rather careless. He told me that this sickness was confined largely to the men who exposed themselves to the weather—that is to say, the outdoor men, and to those who take rather too much to drink. He said: "If you get them together and advise them for their own benefit to take less drink, and keep a strict hand upon them, it will be better." Shortly afterwards I had occasion to meet them at a large gathering—it was after my election—and I took the opportunity of saying a few words to them, begging them that if they felt they had symptoms of influenza they should report themselves, stop all drink, and go in for Bovril and other nourishing, warm food, and take extra care of themselves.

1600. You do not know from the information which Dr. Forsyth gave you whether your employees had any marked gastric symptoms, diarrhœa or sickness?—Not at that stage.

1601. What amount of drink are your men allowed?—They are allowed three pints of light beer a day.

1602. But I suppose practically they get as much as they like?—The outside men do. That is one of our difficulties. The customers are rather inclined to what is called "treat them" when they deliver beer. In that way the outside men get more drink than they ought to have. I may say that we do not allow drunkenness in the place. We are very strict about that. But some of these outside men, in spite of all our precautions, do get more than the average.

1603. How do you account for no arsenic being found in the sample of your beer which Mr. Salamon examined?—That would probably be a sample of sixpenny beer, into which Bostock's sugars did not enter at all. It was only fourpenny beer which we primed.

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1604. What about the glucose?—It was not Bostock's glucose; it was the American "Climax" glucose.

Only Bostock's invert use for prim but only cheaper primed.

1605. (*Mr. Cosmo Bonsor.*) Brewed with glucose and not primed at all?—That is so. We do not prime anything except the single X beer.

1606. (*Sir William Church.*) It struck me that as your other beers were contaminated, how was it that this one was not contaminated?—We had a large number of brews which were not contaminated at all—large numbers of brews which were certified pure by Dr. Miller; but these were brews of the other grades of beer, and not the fourpenny beer. It was the fourpenny beer which was largely contaminated because of its having invert priming in it.

1607. Would these beers be brewed in the same vats as the other qualities of beer?—They might be, but, generally speaking, certain types of vessels are used for the same type of beer week after week. Usually the same quality of beer passes through the same vessels.

1608. Probably the cheaper beer, the fourpenny beer, would always be made in the same wort tubs and vats?—A good many brews are fermented in slate vessels. That particular type of beer to a large extent is fermented in slate vessels.

1609. These different qualities of beer are not manufactured in the same vats, are they, because if they are it would be a remarkable thing that some beers should have traces of arsenic in them and others not? One would think they would get traces from the vats?—The precautions taken when the vats are emptied are very great. Every vessel is scalded and cleaned.

1610. Did you use any other invert for priming than Bostock's?—No; we have used Bostock's continuously for four or five years.

1611. Absolutely Bostock's?—Solely Bostock's for priming—that is, Bostock's invert.

1612. Had you ever tested the sugar for its quality or purity during those years?—We constantly tested for its quality, but we never tested for arsenic.

Sugars stantly tested brewin value.

1613. You only tested it for its quantity of sugar?—Its commercial value. One thing we guard against in sugar is that we have not got a sugar which, roughly speaking, carries forward a burnt flavour. If you test a sugar that tastes a little burnt, you are apt to think that the acid has not been sufficiently neutralised by the lime which is added afterwards in the process of manufacture. If that were detected, we could immediately stop the use of it, and complain. For many years, to my knowledge, we have not had any samples reported as being insufficient in the manufacture in this way.

1614. It never occurred to you, I suppose, to examine it for anything which might be deleterious? You only examined it so that it should be suitable for your own purposes?—Quite so.

Maltst first u ing to antee

1615. Had you any difficulty in obtaining warranties of pureness from either the maltsters or sugar makers when you required them?—We had not the slightest difficulty in getting warranties from the sugar makers. The maltsters were in very great alarm indeed; but we were firm, and we got the guarantee. Where they held back and did not give us a guarantee, we closed the account. We said: "Your malt may be perfectly pure, but we are under such a strong light of suspicion now as a firm that we cannot afford to forego any possible safeguard, and although every grain of malt in the kingdom may be perfectly free, so long as the public analyst has called attention to the malt, we must have your guarantee or we will close the account."

1616. Your experience would rather go to show that there is no great difficulty in getting guarantees from maltsters?—I think now they have all fallen into line with the exception of one firm, and I do not know whether within the last week that firm has not also come into line.

1617. (*Chairman.*) Your insistence upon a guarantee from the maltsters was after the scare, I suppose?—Yes.

1618. Before that it had not been considered necessary to have a guarantee of purity from the maltsters, had it?—No. My own personal, practical knowledge of the value of malt was quite sufficient to judge the samples, but when it came to a question of purity from arsenic we considered that we certainly ought to have

an absolute guarantee that could not be got round in any way.

1619. And that guarantee implied purity from arsenic, special notice having been called to that?—That it shall be free from contamination by arsenic or other deleterious materials.

1620. (*Sir William Church.*) There are other things used in brewing, I believe, besides glucose and invert sugar—hop substitutes?—We never use them.

1621. Then you can give us no information with regard to them?—I can give you no information at all. We use hops only.

1622. (*Dr. Whitelegge.*) Did you obtain any certificate with the hops?—At the time we got certain certificates from the hop merchants; but I understand that the whole trade has met together since and sent a circular round to all their customers saying that they consider it is unfair of the brewers to ask them for a guarantee of an article over which they have no control, in the growing or in the treatment or in any process until it reaches their hands.

1623. (*Sir William Church.*) That is the hop merchant—Yes, the man from whom we buy.

1624. (*Professor Thorpe.*) The certificate of purity issued by Dr. Miller, which you have explained to us, has reference practically to the wort only, has it not?—Yes. This particular certificate is attached to the cask.

1625. Do you imply that it is a warranty to the licensee?—It is a warranty to us, and we pass it on to the licensee, not with the idea of getting rid of our own personal liability or guarantee in the matter, but with the idea of assuring the customer that we have taken all precautions to obtain the best scientific certificate we can.

1626. The legal position of that certificate is that it refers not to finished beer, but to some substance which is in an intermediate stage?—It is the finished beer with the exception of the priming. That is what you mean, I suppose. Dr. Miller, besides, gets frequent samples of the beer taken from the cask as well but we thought if the certificate applied to the beer at a stage where arsenic was most likely to be found, if at all, that that would be an extra precaution, because we could not give him samples of every barrel of beer out of the thousands and thousands of barrels in a week. We could not give him a sample from every particular cask, so he used the words: "I certify the purity of the brew of beer from which this cask is filled."

1627. I should like, if we could, to get the legal value of this as a certificate. Would the licensee, whose beer was taken by an inspector, and was found to contain arsenic, be in a position to point to that as a warranty?—I should say that the licensee would look to us for any liability that he might be exposed to, so that if he had an action brought against him, he might be able to bring an action against the brewer.

1628. But would this enable you to be immediately connected with any police prosecution based upon the action of the public analyst?—From a legal point of view it is possible that it might not, because the legal action, so far, has been taken against the retailer. It may be perfectly legal, but I think it is very wrong and unfair. I think the brewer ought to be prosecuted, and not the retailer.

1629. But, of course, the action has been taken not upon the sample of wort, but taken upon the sample of beer; that is to say, action is taken upon something to which something else has been added after the certificate has been framed: is it not so?—Allow me to correct that. I think besides the sample which is taken at an early stage, although Dr. Miller does not get samples from every cask (he cannot do so) he has one sample from every brew after the beer is finished.

1630. I think we have been rather at cross-purposes?—May I say that where the misconception has arisen is that this invert sugar is not put into the cask. It is put into the racking tun—mixed altogether in the racking tun.

1631. That may be so, but it has been added to the material at a stage subsequent to that product which Dr. Miller's certificate has reference to?—Yes.

1632. Therefore to that extent the certificate is not valid so far as the finished beer is concerned?—I quite see your point. I think that besides many samples at the early stage, Dr. Miller has one sample at the finished stage out of what I call the racking back.

1633. Your machinery for ascertaining for your own purpose, and even for the satisfaction of your licensee, is no doubt adequate. Dr. Miller analyses all along the line, and no doubt with sufficient stringency; but the point I am raising is as to the actual legal value of this certificate as a warranty?—I think we should be legally liable ourselves—we should have to prove that we had taken every precaution—and the retailer who retailed the beer would, I think, be able to come upon us.

1634. Do you think you might immediately, upon the strength of this certificate, be connected with any police prosecution which might be instituted on the ground of impurity in your beer?—I cannot express an opinion about that. I should say one ought to be; we should have no wish to shirk it—not the slightest. That is why I ventured to express an opinion, which perhaps, I should not have done, that it is a shame that the retailer should have to bear the onus of a prosecution because, if anyone was innocent, he was.

1635. In other words, you have no desire under the particular form of this certificate, taken at that particular point in the history of the beer, to eliminate yourself from responsibility?—Most absolutely and emphatically not.

1636. I should like you, if you would, to give the name of the recalcitrant maltster—I hope you will give his name?—I suppose I am right in mentioning it. The maltster who objected to give the certificate in the first stage was Mr. Soames, of Grimsby—Messrs. A. and G. Soames. He considered it was unfair that he should be called upon to take what he considered was a very heavy responsibility.

Guarantee in respect of beer ingredients.

1637. I think you have assured the Commissioners that you had no difficulty with regard to the manufacturers of invert and glucose in getting these guarantees of purity?—Not at all; in fact, the guarantees are attached, gummed on to the invoices, and the dates of the invoices are stated upon the guarantee.

1638. Do they furnish you with these guarantees without being asked for them?—No. We sent a circular letter out to all the traders with whom we dealt, and they immediately responded. That was their own form of words. It was exactly what we wanted, and we have adopted it with other people.

1639. I gather that the guarantee was rather in the nature of a general guarantee of purity?—I do not know whether you have had a copy of what was sent out. It was the guarantee issued by Messrs. Garton, Hill, and Company. I thought the wording so satisfactory that we adopted it.

1640. Have you required all the others to adopt the same form of guarantee?—Yes.

1641. (*Mr. Cosmo Bonsor.*) In Manchester? — The people with whom we trade.

1642. (*Professor Thorpe.*) I suppose it is within your knowledge that it is not the exact form adopted by the various makers and sellers of this article; you may have imposed it upon them?—Possibly we did. I should like to see whether our letter gives any suggestion as to the wording.

1643. The form of guarantee issued by Messrs. Garton, Hill, and Company is a form to which the signature of the analyst is attached, and it is countersigned by Mr. Richard Garton himself, I think?—I am not quite sure, but I believe it is.

1644. Anyhow, I take it from you that in your opinion the guarantee furnished by Messrs. Garton, Hill, and Company is sufficiently specific?—I think so.

1645. It is not a general guarantee, but it covers the individual deliveries?—Not only that, but in writing upon the guarantee there is a space left for the date of the invoice, and they state the date of the invoice upon it.

1646. That is to say, the guarantee actually connects the warranty with that particular delivery?—Yes. There is no saying that this is a general guarantee at all; it applies to that delivery.

not always in same terms

1647. But the other guarantees are not of that order?—No; but we are getting them into line. At first there was rather a demur. Some people gave it so unreservedly, that I thought they did not know what they were doing. They gave it perfectly freely, so we put these words to them.

1648. I gather that, being satisfied with the direct character of the guarantee furnished by Messrs.

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Garton, Hill and Company, you have imposed a similar formula upon others?—Yes.

1649. Have you had any difficulty in getting them to do that?—We have only imposed this form lately. At first we were content with a general guarantee; but when we noticed the admirable form of Messrs. Garton, Hill's, we imposed it upon others, and, with the exception I have named, they immediately came into line.

1650. Do these guarantees accompany the invoice as a separate document?—Either that, or they are written upon the invoice.

How these guarantees might be systematically obtained.

1651. I gather you think it is desirable that this system should be perpetuated?—It is very possible that it might be wise to do so; but we have only imposed it for the present. It is not for me to dictate to the Commissioners as to whether it should be continued, but it would be a very wise precaution for the brewers. That is my view.

1652. Do you think it would be a wise and prudent thing that this system of giving these specific guarantees should be perpetuated?—I think so, because whatever form of guarantee the brewer gives, there is no doubt in my opinion that if not legally, he is morally liable. That being so, I think he ought to take all precautions necessary, and insist upon every cover he can possibly get as well.

1653. Even although you do impose a precisely similar formula upon every vendor of invert or glucose, you yourself have no knowledge to what particular test this formula applies?—No, I cannot say that I have; but I think it would be the Marsh test which is usually adopted.

1654. It may be one thing or another?—It might be, but it conveys to us that it has passed a satisfactory test, and that it is free from arsenic or any other deleterious substance.

1655. But who is the judge of the satisfactory character?—We check every delivery ourselves.

1656. You yourself use a test to see that the guarantee is fulfilled?—Many tests out of every consignment we get.

1657. You are in some respects exceptional. There are lots of brewers not so well equipped as you are with scientific assistance?—If they have not got it themselves, I think they are employing it. It is my view that they ought to do so.

1658. Has every small brewer the means of getting this?—I should say he would send a representative sample, taken from, say, half-a-dozen different bags, if it was glucose, to his analyst. I do not say that is being universally done now, but it would be wise if he did do it.

1659. I do not wish to deprecate any increased precaution or stringency that may be brought to bear but if this guarantee had reference to a standard test prescribed by some authority, and the certificate itself was drawn up in an approved form by an authority, and the certificate bore the signatures, first of the analyst and then of the man who was responsible for his employment, or in seeing that the analyst had done his duty, do you not think that would be a better way of doing it?—It possibly might; but in the case of a small brewer it is natural that he should take all the same precautions as a large brewer; but it would add very much to his difficulties.

1660. If he got a certificate, with the knowledge that everything had been done that ought to be done by the vendor of the article, to some extent his responsibility would be minimised, would it not?—Quite so. For his own protection he ought to have all these safeguards.

1661. These certificates could be attached to the invoices?—Yes.

and checked by Revenue Officers.

1662. And being so attached they would always be seen by the Revenue officers?—If they wished to examine them.

1663. They themselves see the invoices when they like?—Yes, but they do not ask for them frequently. Still they are there.

1664. That is to say, the Revenue officer in charge of the brewery would see these certificates of purity?—Yes.

1665. Would it be any considerable hardship upon you as a brewer if you were required to produce that certificate of purity obtained in the manner I suggest before you took into use any of these products?—It might, in this way—that sometimes a consignment of goods will arrive with an advice before the invoice arrives, and you might want to use the goods immediately. If the Excise officer would not allow you to use the goods, even provided you had personally tested them, without seeing the manufacturer's certificate, it might cause delay in the use of the article.

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1666. Supposing the matter were so arranged that you furnished the Excise officer with the proof that you yourself had tested it, he might not wait for the certificate?—He might. You would not use it yourself unless you were sure.

1667. In the event of the brewery not having a skilled assistant to test those products, and being, therefore, unable to give the evidence of purity to the officer, would there be any hardship upon that brewer being made to wait until the evidence of purity was forthcoming?—I think, perhaps, it would be simpler that he should be able to produce the certificate at once. If such a condition were laid down, I think it would simplify the matter for the small brewer to simply produce his certificate of purity. But in our case I should prefer our own examination first.

1668. I do not wish in any way to lessen that, but what is the difficulty about the certificate of purity going with the advice of the despatch of the goods?—That could be done; but I understand you want it attached to the invoice.

1669. I suggested that because it connects that particular certificate with the particular delivery?—Exactly.

1670. But would there be any great difficulty in getting both the invoice and the certificate?—Not always, but sometimes it might cause a little delay in the use of the raw material.

1671. You do not see any insuperable difficulty in getting the invoice and the certificate together, do you?—I think the invoice and the certificate ought to be together if it is to be of value to identify it.

1672. It should come simultaneously, or even prior to the delivery of the goods?—It should.

1673. Do you see any real difficulty in bringing that about?—There would be no other difficulty than that which I have named—that a man might require to use his materials quickly, and he would not at that time have received his certificate, although knowing it was there.

1674. Were these other sugars which you tested in your laboratory sugars which had been produced by the instrumentality of the oil of vitriol?—They were Garton, Hill's and "Climax."

1675. Then they were?—Yes.

Beer destro

1676. You have destroyed, as you have told us, a very large quantity of your beer, and we at the Government Laboratory have of course received samples of beer relating to what you have destroyed?—Yes.

Claim return duty some

1677. I suppose you have no objection to my asking you questions about the beer you have lodged for rebate or drawback?—No, you may ask me anything you like.

1678. I find that you had 31 brews from the 17th October to the 23rd November. Perhaps you do not remember these details?—We had very many more than that.

1679. You had many more than that, but you had 31 brews which were presumably brewed from arsenicated material?—Yes, 31 brews which contained Bostock's sugar. There were a large number which did not.

1680. You have not sent us any beers which were certified by Dr. Miller as being free from arsenic?—No. The beer we sent to you was beer, I presume, that we had run away, and which was certified by him as containing arsenic.

1681. Has every beer that has been sent to the Government Laboratory been examined previously by Dr. Miller?—I think so; either that, or else it contained Bostock's sugar; I think both. Certainly no beer has been sent to you that did not contain Bostock's sugar or that was not certified by Dr. Miller as being contaminated.

1682. Then there are 31 such brews over that time—from the 17th October to the 23rd November?—Yes.

1683. That was equivalent to about 4,010 standard barrels?—Yes. That is beer which had never left the brewery.

1684. That was the amount of beer that was produced?—Yes, but it had not been delivered to our customers.

1685. Do you happen to know how much you actually destroyed of the beer which had not left your premises?—No, I cannot tell you that without reference.

1686. I may tell you that the official paper shows that you destroyed 104,360 bulk gallons?—Yes; that is beer that had not been sent out of the brewery.

1687. Beers which had not left your premises?—Yes.

1688. But you had produced 144,377 standard gallons?—Yes—you mean actual liquid gallons?

1689. Standard gallons. I want to know what became of the difference. You turned out 4,010 barrels, but you only destroyed 2,899. What became of the difference?—The difference would be in the hands of the customers, and would be afterwards stopped and brought back and destroyed at the brewery, I presume; that is to say, these were portions of brews part of which was in the brewery and part in the hands of the customers.

1690. Are you able to assure us that practically the whole of the 1,000 barrels difference was either brought back by you or destroyed by your employees, or poured down the drains by your customers?—It is nearer 10,000 barrels. The thousand barrels would be the difference relating to these particular brews.

1691. I am speaking of your own firm only?—So am I. Those thousand barrels were a portion of those brews (to which that return relates) which had already left the brewery, and for which we made no claim. In addition to that, there were also thousands of other barrels of which no portion of the brew remained in the brewery, and which were found upon analysis were contaminated. We afterwards got them back from the customers.

1692. All I want to know is whether any considerable portion of that difference was destroyed by the publicans or by your employees?—The publicans themselves destroyed nothing; our employees destroyed everything. It was either destroyed in their own places or it was carted back to the brewery and run down the drains.

1693. Why should you cart it back to the brewery?—It was very largely a matter of policy. It would have been less advertisement of a wrong kind to us if we had quietly run it down the drains of the customers, as many did, and not brought it back at all. But we thought the proper way of dealing with it was to take it clean away from their cellars, and run it down the drains ourselves. As a matter of fact, either my co-directors or myself, or our chief brewer, were there practically day and night to see, and to make sure, that the whole of it was run away.

1694. Have you any idea as to how much arsenic there was in those products which you used—the invert and the glucose?—I have not got the exact figures. They were in varying degrees of contamination. Some were very seriously contaminated, and others very slightly.

1695. Were the samples of the brewing materials taken by our Revenue officers taken with your knowledge?—I think so.

1696. Do you know the particular samples they took?—Yes; I should know at the time.

1697. Were those samples more than averagely contaminated with arsenic?—I should say you might take them as average samples.

1698. Does it strike you as a large amount, that invert should contain 1·6 grains of arsenic per lb.?—I think I have heard those figures as being the result of an analysis of a sample of Bostock invert.

1699. And does it strike you as a large amount that glucose should contain 2 grains per pound?—That, I should think, would be a very bad sample, because our own tests revealed the fact that it varied very considerably.

1700. Then the sample we got was not a fair sample of what you have been using?—It was there for your officer to take. I do not know how many samples he took.

1701. You used, in addition to Bostock's glucose and Bostock's invert, certain other sugars, some of which you named, but some of which you have not named. I believe you used a certain amount of caramel?—Yes, we purchased caramel from Duttson.

1702. Do you know who made it?—I believe Duttson is the maker; at least, I have always understood so.

1703. Have you got any caramel from Herring, Giles, and Co.?—We have, but, speaking from recollection, I do not think we have purchased their caramel lately.

1704. Were those caramels examined?—Yes, they were examined for arsenic after our attention was drawn to it. *Mr. J. G. Groves, M.P.* 7 Mar. 1901.

1705. I suppose they would be caramelised glucoses?—Yes.

1706. In the manufacture of caramel does the maker set aside the off-colour glucose to turn it into caramel; is he likely to do that?—That I could not tell you. I do not understand the process of the manufacture of caramel. It is a colouring material made, practically, of burnt sugar. The actual process of manufacture I do not understand.

1707. Bostock's make caramel, do they not?—I am not aware that they do. If they do I have never heard of it.

1708. Is it at all likely that if a sample of glucose had been stained by an unusually bad sample of brown oil of vitriol, that that off-colour glucose would be set aside and turned into caramel?—I should not think so.

1709. What is caramel mainly used for?—For getting uniformity of colour. If you have malts varying slightly in colour, and you want to have them exactly uniform, it is by the tintometer that you bring up the standard of colour by the use of a little caramel, if needed.

1710. At what stage is the caramel added?—In the copper. When you take your sample before you run off, you add a little caramel to get the colour.

1711. Is it likely that any process through which the beer is going would tend to eliminate arsenic from the caramelised material?—There would be a tendency to filter anything through the hops before it was run into the cooler. I should think the hops would act as a filter medium for anything of that kind.

1712. (*Chairman.*) Is caramel largely used in beer?—It would not be used at all in pale ales; but where you have varying colours of malt you use a little caramel to bring it up to the standard.

Amount of arsenic added in priming with Bostock invert.

1713. (*Professor Thorpe.*) The invert sugar that you use for priming would, in the proportion that you use it, mean that you add to 36 gallons of beer 3 grains of arsenic?—It is possible that in some samples you might get that.

1714. You told me that you thought the 1·6 grains in the invert was an average amount?—Those were your figures. When you mentioned it I recollected that I heard that 3 grains were found in one sample, but I could not tell you whether it was an average, or whether it was below or above.

1715. I think you also told me that the sample taken by our officer was an average invert?—It was taken from a bulk of invert; but I could not tell you whether it was an average of the total. We found in our experiments that it varied very exceedingly.

1716. The glucose, but not the invert?—Yes; the invert too. That is to say, the amount of arsenic in the invert and glucose varied in the samples we took. Some were more highly contaminated than others.

1717. Assuming that 1·6 grains per pound was the amount of arsenious oxide in the invert, and assuming that you added to a barrel 1 9-10ths of a pound of this invert, you would have added something like 3 grains of arsenious oxide to the barrel?—Yes; if those figures are correct; but it is evident that it does not apply all round. We have had several samples, varying from 1-50th of a grain to 1-200th of a grain per gallon, in cases upon which prosecutions have been laid.

1718. In beers to which priming has been added?—Yes. Taking the sample of 1-200th part of a grain, that could not possibly have contained as much as you say; still, a prosecution followed. It is pending, and that was the certified amount.

1719. I do not put forward those figures as being of any other value except that they follow certain data that I have laid down?—It seems to me alarmingly high. I should not like to have it on my conscience that all this contamination had been as serious as that; in fact, I could hardly credit that it would be so.

1720. Has your chemist, Mr. Stone, or has Dr. Miller specially searched your products for selenium?—No; Mr. Stone has not. As far as I have heard of selenium, it is somewhat in the theoretical stage. We have heard it mentioned as a possible source of contamination.

1721. But you are not aware that Dr. Miller has caused any examination to be made with respect to it?—I think very probably he would have done so.

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1722. Would he have informed you?—He might have been experimenting to keep himself in touch with every theory raised; but personally I have not heard of this, except that in a general sense the theory of selenium has been mentioned.

Varieties of beer brewed.

1723. (*Chairman.*) What kinds of beer are brewed by your firm—several different kinds, I suppose?—Single X., mild ale; F., mild ale; XX., mild ale; C., mild ale; two strengths of bitter ale, and three qualities of stout.

1724. I think you said that the invert was only used as priming for the single X?—Yes, the single X quality.

Sugar used in given brew could be traced.

1725. Do your books show how much Bostock sugar may have been used in each particular brew?—Yes; our brewing books show exactly every ounce used in every form.

1726. As a general question, what proportion of glucose is there in each kind?—You may take it, roughly speaking, at about 10 per cent.; that is to say, it replaces 10 per cent. of malt.

1727. Nine-tenths of malt, and 1-10th of glucose?—Yes.

Amount of glucose in Groves and Whitnall's beers.

1728. As a general rule?—Yes; roughly speaking; it varies. It is as much as 12½ per cent. in some cases and as low as 8 per cent. in others.

1729. Would it be possible to make a good beer with glucose alone, instead of malt, supposing the glucose to be thoroughly perfect?—I should hardly like to go so far as to say that you could brew beer from glucose alone. I think it is very admirable in combination with malt.

1730. But not as a substitute for malt; but only as a substitute for a certain proportion of it?—Yes. We do not use it very largely. Some brewers use it very much more than we do. From 8 to 12½ per cent. is about what we use.

1731. Does the proportion remain the same all the year round in a certain kind of beer? Do you use different proportions in the summer from what you use in the winter?—We use the same in summer as in winter.

Certificates of freedom of beer from arsenic relate to Expert Committee's test.

1732. (*Dr. Whitelegge.*) You give a certificate with each consignment of beer sent out at the present time?—We attach a certificate fastened on to the barrel.

1733. What do you understand that certificate to mean? Does it mean absence of arsenic in a quantity detectable by the test of the expert committee?—It means that it has passed the test laid down. I may tell you that all our brews do not come within an approachable distance of the test, which is very much freer than the test we allow them to pass would show.

1734. So that you regard the test as a lenient one?—Yes; so far as we are concerned. We could pass a much stricter test.

1735. (*Sir William Church.*) You supply, I believe, a number of tied houses?—Yes.

1736. Of course, you had no difficulty in getting back the beer from those houses?—No.

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1737. You also supply free houses?—Yes.

1738. Had you any difficulty in getting your beer back from them?—In many cases we had to use very great persuasion to get the people to understand that there was any danger, or that there had been any danger. They drew a sample of beer, and said, "Look at this; it is beautiful; do you want to ruin us, and close the house?" We said, "You will have to close the house if necessary, but you must not sell a gill."

Withdr of cons ated be from pu cans.

1739. That would be with regard to tied houses?—Free customers as well. We had to use a good deal of persuasion. We said, "We are doing this for your protection, and for the protection of the public; you must not sell a gill." In some cases the travellers admitted when they reported to me that they had some difficulty in persuading people that it was not all moonshine.

1740. (*Dr. Whitelegge.*) Were any of those houses at a distance from Manchester?—Some were, but I may say that we do 86 per cent. of our trade within a 3-mile area of the brewery.

1741. (*Sir William Church.*) So that you do not think any large quantity of your accidentally arsenicated beer remained unwithdrawn?—No. We sent out a third circular on the 12th December as an extra safeguard, asking our customers for a return of anything still remaining in their possession. That brought out the fact that there were about 100 barrels out of the whole 10,000 remaining, and those were in outside places that we had not got at; they were lying there waiting to be removed. They were removed soon afterwards or destroyed on the premises.

1742. (*Chairman.*) I am sure the Commission feels that the public is indebted to you for your conduct through this crisis. Your prompt action on the 12th and 13th November has, I am sure, obviated much severe illness and saved many lives. Had it not been for the great promptitude of the action you took, we may believe the disaster would have been much more serious than it has been?—I am sure I am very grateful, my Lord, for that expression of opinion. It has lifted a very great load from my mind, for I am bound to say that I am so constituted that I perhaps take these things rather more conscientiously to heart than I should. I have felt that our company has perhaps suffered under a greater load of misapprehension than our neighbours; and while the extent of our business may have made us the innocent channels of a greater amount of trouble than some of our neighbours, I am glad to hear you say that you think the action we took at the time has prevented the mischief from spreading beyond the area in which it originally started.

Mr. E. W. T. Jones, called; and Examined.

Mr. E. W. T. Jones.

1743. (*Chairman.*) I believe you are a Fellow of the Chemical Society, and public analyst for the county of Stafford, and the boroughs of Wolverhampton, Walsall, Kidderminster and Newcastle-under-Lyne?—Yes. I have been a public analyst for about 28 years.

Samples tested for arsenic in Staffordshire.

1744. I believe you have tested many samples of beers?—Rather over 300.

1745. Previously to last December, have you tested many?—Not a very great many, only a few now and then as a public analyst.

Beer.

1746. And since last December?—I have tested about 300 samples; as a matter of fact, it is over 300 at the present time, because I have tested some since I wrote this report.

1747. Did you find many of these samples arsenical?—26 samples were decidedly arsenical.

1748. To the extent of what?—To the extent of from ½ to 1-20th of a grain.

1749. Per gallon?—Grain per gallon, calculated as arsenious oxide.

1750. The small quantity of one-sixtieth of a grain to a gallon, would that have escaped your test?—I do not consider so.

1751. Your test would have touched even one-sixtieth of a grain per gallon?—I consider so now.

1752. Thirty-three samples contained arsenic under one-twentieth of a grain per gallon?—Decidedly under one-twentieth of a grain per gallon, but 15 of those were from one brewer, after the use of Bostock's arsenical glucose had been discontinued; and I found that those traces of arsenic in those beers were entirely due to the malt used.

Mr. E. W. T. Jones. Arsenic in non-poisonous beer.

1753. Entirely due to arsenical malt and not to glucose?—Yes.

1754. Then these 15 were supplied after the brewer had discontinued the use of the contaminated glucose?—That was so.

1755. To what do you attribute the slight amount of arsenic in the other 18 samples?—In the other 18 samples they came from brewers who had previously used arsenical glucose; so whether these small traces of arsenic in these 18 samples were due to contamination left in the yeast, or from an arsenical malt, we have not been able to discover. But it is a curious fact that all came from brewers whose beer had been condemned for being decidedly arsenical.

1756. And as to home-brewed beers?—Every one of the home-brewed beers I found to be free from arsenic.

1757. Were the home-brewed beers made, generally speaking, from the same malt as the beer made by public brewers; was it obtained from the same sources?

—This one particular malt which we have condemned came from Yorkshire. As a general rule, you found none of the home-brewed beers were arsenical?—That is so.

1758. Do you know what malts and what materials were used in the home-brewed beers?—I do not positively know; but inasmuch as I found no arsenical beer in any of our local breweries, except those which had used arsenical glucose, I presume that our local malts, at any rate, are free from arsenic.

1759. (*Sir William Church.*) What do you mean by "home-brewed beers"?—Beers brewed by the publicans themselves on their own premises.

1760. Very few private individuals now brew beer for their own use; those would be public-house keepers who kept small breweries?—That is what I take it to be from the information supplied to me. I would receive a sample, and I would get a note saying so-and-so is home-brewed beer. I took it that it was the publican who brewed upon his own premises.

1761. (*Chairman.*) I believe you have tested samples of malts?—Yes, thirteen samples of malt. Eight of those samples were from one maltster, three of which were decidedly arsenical, containing from one-fortieth to one-fiftieth of a grain of arsenious oxide per lb. The remaining five were slightly arsenical, with apparently less than one-hundredth of a grain per lb.—just detectable by the test. The five samples, representing three maltsters, local to Wolverhampton, were free from arsenic.

1762. Do you know what fuel was used?—I do not know what fuel is used in our districts; generally coke, I think, but I do not know what kind of coke. I have examined none of the fuel for arsenic, but I apprehend that it does not contain any sensible amount, otherwise I must have had the arsenical malt, or the arsenical beer from that malt.

1763. To what fuel do you attribute the arsenical character of the malt?—The arsenical malt in every case goes back to Yorkshire gas coke.

1764. Have you examined the constitution of that coke?—I have not; I have not been able to get a sample, but I have been promised one. It is rather out of my district.

1765. You have not examined any of the coal or coke in your district?—No, not for arsenic.

1766. Indirectly, do you form any conclusion?—Indirectly, I do not think that they can be sensibly arsenical, inasmuch as I must have condemned some of our local beers, or some of our local malts.

1767. You have not had any arsenical beer in the composition of which Bostock's sugar had not entered?—Except those private samples from the malt to which I referred.

1768. Have you tested the sugars?—I have tested 25 samples of brewing sugars, eight different makes, and in no case have I detected arsenic, with the exception of two samples of Bostock's. Those contained ·023 and ·021 per cent., or 1-10th of a grain per ounce; or, to put it as Professor Thorpe put it, 1·6 grains per pound.

1769. (*Professor Thorpe.*) Were those inverts or glucoses?—Both.

1770. (*Chairman.*) 1-10th of a grain per 1-16th of a pound?—Yes.

1771. That would be 16-10ths of a grain per pound?—Yes. I had one sample of Bostock's glucose sent to me privately that contained double that quantity—·05 cent.

1772. (*Professor Thorpe.*) Where did you get that sample from?—It was a private sample sent from Liverpool.

1773. Can you inform us how you got it?—It was sent to me by Mr. Collingwood Williams, of Liverpool.

1774. He was the County Analyst, I believe?—Yes. Up to that time I had come across no such sample of arsenical sugar, and I wrote to him to send me one which he was examining.

1775. That was a sample he was examining in connection with some of these inquiries, I suppose?—Yes.

1776. (*Chairman.*) Have you tested any samples of cane-sugar?—I have tested two samples of cane-sugar used for brewing, and both were free from arsenic.

1777. Have you tested any samples of treacle and golden syrup?—I have tested 25 samples which were all free from arsenic. Some of the samples of treacle were adulterated with glucose syrup, but still they were free from arsenic. *Mr. E. W. T. Jones.* 7 Mar. 1901.

1778. Would you consider glucose an adulteration of golden syrup?—Undoubtedly. A prosecution took place yesterday in our court on one of my certificates, and a fine was imposed.

1779. Do you think glucose would be an adulteration of treacle?—Undoubtedly.

1780. Have you tested samples of jams, marmalade, and mincemeat?—Yes; I have tested 17 samples, all free from arsenic.

1781. Would glucose be an adulteration in jam or in marmalade?—I do not consider it would, though some analysts would. Glucose an adulterant of certain foods.

1782. Is there any rule for the guidance of analysts with regard to adulterations such as that?—Only from common sense.

1783. (*Dr. Whitelegge.*) Which leads them to different conclusions?—Sometimes. I certainly think that glucose is a perfectly legitimate constituent of jam. There is no strict formula for jam.

1784. (*Chairman.*) Is it not also a proper constituent of golden syrup?—No.

1785. Is there a definition of golden syrup?—Golden syrup is a syrup run from a natural product; it comes from the refining sugar; but jam is a made-up article in which I apprehend they could use beet sugar or cane-sugar, or I should say they can use a certain amount of glucose if it improves the quality of their article to the palate or prevents crystallisation.

1786. Have you tested honey?—Yes.

1787. Would glucose be an adulteration of honey?—Undoubtedly I should condemn honey with glucose.

1788. Have you tested any samples of confectionery?—Yes. I have tested 27 samples of confectionery of various kinds and colours. No arsenic in coloured confectionery.

1789. Have any of them been of brilliant colour—a brilliant green, for instance?—Some were green. There were a lot of various colours.

1790. Were all those samples free from arsenic?—Yes.

1791. Was there any Scheele's green in any of them?—No. We used to have chromate of lead in sweets, but that has now gone. We have had a prosecution for that.

1792. Have you tested any sample of brewing materials?—Two samples of brewing materials. Two samples of bi-sulphite of lime, one of sulphurous acid, and one of finings. All were free from arsenic. or sulphites.

1793. What is your method of testing?—My method of testing is very similar to that recommended by the experts of the Manchester Brewers' Association. There is only a very little difference in detail.

1794. Do you think that such a small quantity as 1-20th of a grain per gallon could be estimated quantitatively by that test when that test declares that there is not arsenic; does it allow you to estimate so small a quantity as 1-20th of a grain per gallon?—Much less. I am quite sure I could detect 1-10th of a milligramme—that would be 1-36th of a grain in the quantity I use. Delicacy of test employed.

1795. Would that show crystals?—I should get distinct crystals from that.

1796. If it were 1-200th of a grain per gallon it would be impossible to see the crystals, would it not?—With that quantity undoubtedly, but we could increase the quantity of beer and bring it back again.

1797. If you took 2.000 c.c.'s instead of 200 c.c.'s you would see the crystals?—Yes.

1798. Have you used larger quantities than 250 c.c.'s?—I have not in a general way. The samples would not allow of my first making a qualitative test, and reserve a portion for a quantitative estimation, if requisite. I stuck to 250 c.c.'s.

1799. I believe you have described your method in the *Chemical News* of the 18th January this year (*Appendix* No. 6)?—That is so.

1800. And you have also described the process for obtaining quantitative results?—That is also described in the same number of the journal.

1801. Is it a very laborious and difficult process to obtain those results?—It requires very great care. It takes nearly two days to get at the results. The most scrupulous care is absolutely necessary.

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1802. I suppose the Reinsch test, so far as it is specified in the report of the experts, could be completed within two hours?—Yes.

1803. Are the results you have obtained generally consistent with those calculated from the materials used?—Yes. Of course, I did not know until I got the report as to the key of what the material was that had been used. That is given in Dr. Reid's report to the Staffordshire County Council. In one sample I calculated that I should, if the formula given were correct, find ·8 of a grain per gallon; as a matter of fact I only found ·38—scarcely half. Another sample calculated from the materials given should have contained ·51 grains. I found and reported ·53. In another sample that should have contained by calculation ·18, I reported ·13. In another that by calculation contained ·22 I reported ·16. So that with the small quantities my results are very consistent with the formula. Whether I got hold of the particular beer with eight ounces of Bostock's glucose I cannot tell; at any rate, I did not get half the amount of arsenic that should have been in it had eight ounces of Bostock's glucose of the character I have experience of as being used.

Variation in quantities of arsenic in Bostock glucose.

1804. There is only one case in which there was so large a discrepancy?—That is all.

1805. Is it possible that arsenic can have been eliminated from the beer by the action of some other chemical constituent of glucose?—No. I think the discrepancy occurs probably from my not getting a sample entirely of this brew, or there was a variation in the character or the glucose that was used.

1806. (*Sir William Church.*) Before the question of arsenical poisoning arose in beer, were you in the habit of occasionally having samples of beer submitted to you for analysis?—Yes.

Usual nature of analysis by Public Analysts.

1807. When that was the case, for what purpose were those samples submitted?—For adulteration under the Sale of Food and Drugs Act.

1808. What used you to look for?—I never looked for arsenic.

1809. I suppose you looked for salt?—We always looked for salt. We generally look for hop substitutes, although we could not have done anything if we found them. We look for preservatives, salicylic acid. We have had one or two prosecutions in the case of salicylic acid. That was in lager beer, and not English brewed beer. Only in the case of salt and salicylic acid in my office as public analyst have I had prosecutions for the adulteration of beer.

1810. (*Chairman.*) How does salicylic acid get into the beer?—It is put into this light beer for the purpose of preserving it. They tried to persuade me that meadow-sweet was one of the natural constituents of lager beer, and that it got in naturally, but the magistrate did not see it in the same light as they did.

1811. (*Mr. Cosmo Bonsor.*) Have you analysed any temperance drinks for salicylic acid?—I do not think so.

1812. It came out before Lord Pembroke's Committee that considerable quantities of salicylic acid were used in temperance drinks?—I am afraid we can do very little with that at present. I may say that we get salicylic acid in quinine wine.

1813. (*Sir William Church.*) May I take it that when beer was submitted to you and other public analysts for analysis it never entered your minds to test it for arsenical or antimonial poison or anything of that sort?—No. In the first place, it is not really an adulteration; it is a contamination. Perhaps we ought to have sought for all these things, but a public analyst cannot seek for everything under the sun with the number of samples he gets, and I do not think it would be of very great avail if he did. It would limit his work to such a degree that his usefulness would be curtailed.

1814. (*Chairman.*) Do you not think that legislation which would increase the power of action, and the number of analysts if necessary, so as to secure the detection of contaminations, would be for the public interest?—I do not think so. I do not think that a public analyst will now have a sample of beer but what he will look for metallic contamination. I have known all my life that sulphuric acid has been contaminated with arsenic. As a chemist I know that it is used for the manufacture of glucose from starch, but I never thought that a manufacturer of glucose would use an arsenical acid for making a product, because it would re-act upon him if it were found out. It would be his ruin, as probably it will be the ruin of Bostocks. There is not the slightest advantage in using arsenical acid, except, perhaps, the matter of threepence a ton in the price of the glucose made. The difference between arsenical and non-arsenical sulphuric acid is under five shillings a ton. It would only make a difference of threepence a ton on the glucose made. It is not worthy of consideration from a manufacturer's point of view.

1815. (*Professor Thorpe.*) We gather from you that practically the only arsenicated food or drink within the range of your experience is this particular beer brewed from Bostock's glucose?—That is so, except in the case of arsenical malts. It has opened that question up which I do not think we should otherwise have found out.

1816. Is it your opinion that there is no occasion for public anxiety with regard to food and drink being contaminated with arsenic, other than what we are immediately dealing with?—That is my contention. There is no cause for anxiety.

1817. In certain of these cases I suppose the articles you have examined have been produced, proximately or remotely, by the agency of sulphuric acid—the glucose, for example, in jams and marmalade?—Yes. I apprehend that almost all the glucose is made by the aid of sulphuric acid. For instance, the liquid glucose in jam is made from maize starch, with sulphuric acid.

1818. I presume you have selected the particular instances which you have given here on the ground that products in which oil of vitrol has entered into the manufacture may have been used?—I selected them out of my samples as simply bearing upon the question before you to-day. They were sent to me by the inspectors by the order of their committees.

Selection of samples for public analysis.

1819. But what led them to the particular selection of the articles?—Very probably I should tell them that they had better go to so-and-so. The papers told them about the glucose.

1820. What led you to tell them to take samples of particular articles?—Simply to satisfy the public mind that any article that was liable to adulteration with glucose was or was not arsenical.

1821. In other words, it was the possibility of oil of vitriol remotely or proximately used in the preparation of these things which led you to select them?—Yes. A great many were selected by reason of our mayor being a medical man, and his reading the medical papers. He told the inspectors to get these things and submit them to the public analyst.

1822. Do you think there would be any practical difficulty in obtaining fuel for the malting kiln free from arsenic?—I do not know. I do not think we have any arsenical fuel in our neighbourhood, otherwise I must have fallen foul of some of the local brewers.

1823. (*Chairman.*) Do you think that the gas coke in your neighbourhood is free from arsenic?—I should say so.

Arsenic in gas coke.

1824. (*Professor Thorpe.*) Is the gas made in the neighbourhood of Wolverhampton and other places a highly sulphuretted gas?—There is a fair amount. The limit is 25 grains per 100 cubic feet—that is of sulphur in all forms.

1825. Is that more than the average amount?—It is considered a fair gas, I should think.

1826. I ask, because I suppose we may take it that there is a rough connection between the amount of sulphur in a coke, and the amount of arsenic which may be present?—Yes; that it to say from the pyrites present in the coal.

1827. I suppose in the original coal the arsenic present is a double sulphide of arsenic and of iron, is it not?—Yes, I should say so.

1828. Therefore *primâ facie* a gas which was rich in sulphur might be derived from coal rich in arsenic?—It may be so. It is more likely to be than one with less sulphur in.

1829. The experience of the authorities where coal gas is made would be an indication of the quality of coke, as regards the arsenic which they turn out. Is not that so?—Yes; I think that some of our gas coke must be used by some of our local maltsters. In fact, I feel quite positive that it is. I have examined a number of locally made malts, and found no arsenic; therefore I presume that our gas coke is not arsenical—at any rate to any appreciable extent.

1830. What was in my mind is that a person buying coke, even supposing he used gas coke, would be able to draw a very fair inference as to the quality of the

T. coke from the fact that the raw gas was or was not largely sulphuretted, would he not?—I think so, but I am not quite sure that it would be safe.

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1831. It is a criterion, that is all. For example, if I wanted to buy coke for kilning purposes, I should take very great care to keep clear of it if I knew that it was produced in a gas works where the labour on the sulphur purifiers was very great?—Until tested.

1832. I should not select it by preference?—I think you would be justified in not doing so. When I said 25 grains I was not speaking of crude gas. We have to purify it to that.

1833. I had rather reference to the crude gas?—Unfortunately I could not speak about that.

ck 1834. (*Chairman.*) You told us that you had one sample of beer which proved arsenical, in which Bostock's sugar had not entered, and that you attributed the arsenic in that beer to the malt. Can you tell us approximately how much arsenic there was per gallon in that beer?—Approximately it was certainly well under one-twentieth of a grain per gallon. I did not actually estimate it.

1835. But it was readily ascertainable by the Reinsch test?—Yes, applied as I described. Perfectly distinct and unmistakable crystals were obtainable. I have some that I can show you, if you desire.

1836. In the other arsenical beers which you tested there might have been considerably more than 1-20th of a grain per gallon, might there not?—Yes; they varied up to half a grain.

1837. (*Sir William Church.*) Had the local malts which you tested been brushed and screened?—I should say they had, from their appearance.

1838. But you are not positive?—They had certainly been screened, because there was no malt dust in them. I think that although screening may rid an arsenical malt of some of its arsenic, I do not think it will ever bring it down sufficiently free to make it safe or judicious to use it.

1838*. After brushing or screening?—That is my opinion.

1839. (*Dr. Whitelegge.*) Were those malts in the condition in which they were used by the brewer?—What I found was that 1-40th of a grain per pound had been screened. I do not say that it had been brushed.

1840. It was in the state used by the brewer?—Certainly.

1841. So that, taking 2lb. of malt per gallon of beer, it might give rise to 1-20th of a grain per gallon?—I do not think it would all enter into the beer. Arsenious oxide is not a very soluble substance.

1842. (*Chairman.*) Do you think it might be deposited and carried away in the yeast?—It remains insoluble, either sticking to the grains themselves or filtered away by the grains themselves. I did not do the analyses of the beer and of the malt; that is only a supposition.

1843. (*Dr. Whitelegge.*) That would rather explain the absence of any arsenic in beer due to the use of malt dried by coke fumes. You said just now, did you not, that much of the arsenic in the malt would disappear without entering permanently into the beer?—I say it is quite possible that some of it would.

1844. But as far as that goes, it would tend to explain the absence of arsenic in beer if prepared from malt dried from coke fumes?—This malt was dried by coke fumes, and that is the reason it became arsenical.

1845. I understood you to draw the conclusion from the general absence of arsenic in the beer samples which you had examined—in your local malts—that the coke fumes could not contain arsenic?—Not to any appreciable extent. But some of the arsenic, surely, would go into the beer from the arsenical malt under local circumstances, the same as if it had been made in Yorkshire.

1846. Then it is the absence of arsenic in the malt and not in the beer, that leads you to the conclusion?—Both; because I did not find any arsenic in any other samples of beer but what go to the use of Bostock's glucoses, with the exception of those I spoke of, and which we found were traceable to one particular arsenical malt. Curiously enough, when they were submitting these samples I always found their bitter beer was free from arsenic, and I thought that these traces of arsenic which I was detecting were due to contamination by yeast or the vessels from the previous use of glucose. The brewer came to see me, and he said, "Your theory I feel sure is wrong. It is not entirely due to contamination. It is due to malt." I said, "I am very surprised if it is due to malt. I will ask you one question. Do you use the same vessels and the same yeast for your bitter beer?" He said, "Yes." I said, "Your bitter beer is never arsenical." He said, "No, because we never use this particular malt in it." I may say that I never condemned, nor did I ever find any arsenic in their bitter beer; but I was continually finding it in these beers in which there was a portion of the malt, or entirely the malt, from this particular Yorkshire firm.

1847. You could exclude in these cases any idea of dilution of arsenicated beer?—I could not positively prove it personally. This was a very respectable man who came to me.

1848. Are you satisfied that that did not happen?—I am quite satisfied that he was simply acting in his own interests, and trying to find out the mystery.

1849. (*Chairman.*) Why did he not use that particular malt in the bitter beer?—I cannot tell you the trade reason. I suppose it was not so suitable for that particular class of beer.

1850. Was it known to be of an inferior quality of malt?—It was chiefly foreign malt. I cannot say why he did not use that particular malt.

Breweries which supplied arsenical beer.

1851. (*Dr. Whitelegge.*) Can you tell us from how many brewers the arsenicated samples came?—I should think about 12.

1852. There were about 100 brewers approximately, of whom 30 were home brewers, leaving 70, and out of that 70 there were 12 whose beer contained arsenic; is that so?—I do not know the brewers myself. I took Dr. Reid's report, and he said that the beer samples submitted to me represented so many brewers. I have ascertained from other sources what the other samples represented, and I make out that the 300 samples I tested represented 100 brewers. I find 13 breweries were arsenical.

1853. (*Chairman.*) Could you give us the names of those brewers?—I will send the names in to the secretary. You will, however, be better able to get that information from Dr. Reid than from myself.

1854. (*Dr. Whitelegge.*) Among the 300 samples, you mentioned 26 as being arsenical in one group, and 33 as being arsenical in a second group?—That is so.

1855. Deducting those 59, we have 241 approximately in which you found no arsenic?—Yes.

1856. Might there have been arsenic in a small quantity of those, say 1-50th of a grain?—I think I should have suspected if there had been 1-50th of a grain.

1857. If there were any arsenic it must probably have been less than 1-50th of a grain?—Yes; I should say so.

No Central Authority instructs Public Analysts what to look for.

1858. Have any instructions been formulated for public analysts by any authority as to the examination to be made in the case of any article of food, substances to be looked for?—No.

1859. In the years prior to 1900, it was not your own practice or that of public analysts generally to examine beer for arsenic or other deleterious substances, but simply for salt and hop substitutes, is that not so?—We generally looked for them. Those were the chief things.

1860. Those were what you looked for as a matter of routine?—Yes.

1861. No suggestion has been made to you in any official way as to any routine in the examination of beer samples?—No.

1862. Having examined for salt and hop substitutes and salicylic acid, what form did your certificate take if you had no exception to take to the sample?—I simply marked it as "genuine." "I am of opinion that this sample is genuine," and pass it.

1863. Without a statement of what it had been examined for?—Undoubtedly.

1864. Would it be convenient if official instructions were drawn up and issued?—I do not think it would be any help.

Should be left to Public Analysts' judgment.

1865. Do you think it is better left to each public analyst?—Yes. He might restrict himself entirely to certain tests. Some public analyst might possibly try and shield himself, and say, "I have sought only for

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those things I was instructed to seek for," and he would seek for no more. Now his duty is to seek for everything which he thinks it is desirable to seek for.

1866. (*Chairman.*) Whether for contamination or adulteration?—Yes. If I suspected arsenic, it would undoubtedly be my duty to look for arsenic. I cannot get out of that duty. If there had been any reason for looking for arsenic I should be greatly blamed for not doing so. There is no doubt about that.

1867. (*Dr. Whitelegge.*) And you propose to continue in the future to look for arsenic?—Yes. I shall take care to do so; but I do not suppose that I shall ever find it again.

1868. What were the impurities which used to be found in beer in former years, and which it would be proper for you to look for?—I used to look for Cocculus Indicus, but I no longer look for it. I used to look for strychnine in the early part of my career, but I do not do so now.

1869. Will the time come when you will no longer look for arsenic?—Not in my time, probably. *Mr. E. Jon*

1870. Would you say that the method of analysis ought to be left to the individual analyst?—Yes, I think so. There are some processes that one analyst by personal equation cannot work so satisfactorily as another, although he would arrive at the same conclusion. I do not believe in too much dictatorial instruction from headquarters to an officer who is supposed to have some brains. 7 Mar.

1871. (*Professor Thorpe.*) With regard to that particularly bad sample of glucose which you got from Mr. Collingwood Williams, and which contained ·05 per cent. of arsenious oxide, have you done anything beyond determining the amount of arsenic in it?—No; I only had a very small quantity. I do not think I had more than about 2 or 3 grammes left after I had weighed out the quantity for the arsenic.

1872. I suppose you did not search for any evidence of selenium?—No, I did not. Selenic looked

FIFTH DAY.

At Westminster Palace Hotel.

Wednesday, 13th March, 1901.

PRESENT:

The Right Hon. Lord Kelvin (in the Chair).

The Right Hon. Sir William Hart-Dyke.
Sir William Church.
Professor Thorpe
Dr. Whitelegge.

Dr. Buchanan, *Secretary.*

Dr. George Reid, called; and Examined.

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1873. (*Chairman.*) I believe you are County Medical Officer of Health for Staffordshire?—Yes.

1874. Can you tell us anything with regard to the population of Staffordshire?—The estimated population of the geographical county in 1899 amounted to 1,203,485, of which number 296,369 constitute four county boroughs, leaving 907,116 as the population of the administrative county. The administrative county is divided into 57 sanitary districts, of which 38 are urban districts, with a population of 677,968, and 19 are rural districts, with a population of 229,148. There are fifty medical officers of health in the administrative county, seven of whom hold joint districts of two each. The object I had in the inquiry was to arrive as soon as possible at the likely injury which had resulted from the consumption of arsenical beer, and with that object I communicated first of all with the medical officers of health, asking each one to inquire locally of local practitioners, and in addition to that I communicated specially with the members of the medical staffs of the hospitals. There are 14 fairly large hospitals in the county, and the medical staffs of those hospitals comprise 48 physicians. I obtained answers from 44 out of the 48.

Epidemic in Staffordshire and action by County M.O.H.

1875. (*Dr. Whitelegge.*) You took precautions to avoid the overlapping of their replies with those of the medical officers of health?—Yes; in every case I took precautions. A very large amount of correspondence followed the receipt of the returns, and I only accepted as cases those about which there could be very little doubt. There were many cases returned as likely cases of poisoning, but I excluded those, partly because of the answers being insufficient, and in many cases after specially communicating with the notifier.

1876. (*Chairman.*) You asked each local medical officer of health for cases which had occurred in his practice?—Yes; and also cases which he had discovered from inquiry locally among other practitioners.

1877. Would local medical officers of health in private practice have difficulty in some cases in getting information from their brother practitioners?—Not in this case. I think in no instance did they have any difficulty.

1878. (*Dr. Whitelegge.*) Did you receive lists of cases, or merely total numbers, and locality?—The total numbers, the localities, and the possible source of the contaminated beer.

1879. But not the name and sex and address?—No.

1880. (*Sir William Church.*) Were many of the cases, or any of the cases, from the private practice of these doctors, or were they all poor-law cases?—A good many of the cases were from private practice, but the majority, as it happens, did not occur amongst the practices of the medical officers of health. *Dr. G.* 13 Ma

1881. (*Chairman.*) Do you think the numbers given by you may in some cases be understated?—I should think that they are understated rather than overstated.

1882. (*Dr. Whitelegge.*) Were there many from the poor-law officers?—I did not communicate specially with the poor-law officers, and I did not inquire as to whether these returns were from them or not. I could analyse the returns and give that information, but I could not give it now. These are the returns I have compiled:—

Number and Distribution of Poisoning Cases and their Probable Relation to the Implicated Breweries.

The following table shows the number and distribution of the cases (excluding suspicious cases) together with the probable sources of the arsenical beer up to third week in December, 1900.

District.	No. of Cases.	Distinctive No. of Suspected Brewery.
Amblecote (Urban)	5	5*
Bilston ,,	4	88
Brownhills ,,	31	47
Cannock ,,	14	47
Coseley ,,	5	1 and 5*
Darlaston ,,	88	56 and 88
Hanley (County Borough)	5	?
Lichfield (Urban)	91	47
Longton ,,	6	1
Newcastle ,,	3	?
Rugeley ,,	8	47
Short Heath ,,	1	?
Stafford ,,	4	47
Stone ,,	69	3 and 5*
Tipton ,,	13	88
Walsall (County Borough)	4	?
Wednesbury (Urban)	4	54
Willenhall ,,	2	?
Blore Heath (Rural)	3	?
Cannock ,,	3	47 and 88
Cheadle ,,	2	?
Eccleshall ,,	6	27 and 5*
Gnosall ,,	4	3
Lichfield ,,	290	47
Stone ,,	2	?
	667	

* Arsenic not found, but have reason to suppose that contaminated beers were withdrawn before enquiry.

1883. (*Chairman.*) I see that in your table you give the total of 667 cases in the county. Do you think the Commission may understand that not less than 667 cases occurred, or that quite possibly there were many more?—Certainly not less; quite possibly more.

1884. Many more?—I should not say many more. As the information came in with regard to the cases I communicated daily with the Inspectors of Food and Drugs under the Sale of Food and Drugs Act, and directed them to take samples, more particularly in the districts in which the cases occurred.

1885. (*Dr. Whitelegge.*) Who are the inspectors of food and drugs? Are they officers of the County Council?—Yes, they are officers of the County Council. There are two—one for North Staffordshire, and the other for South Staffordshire.

1886. Do they act under your direction?—I advise my committee generally regarding the work under the Food and Drugs Act; but, as a rule, except special cases, one does not interfere with the Inspectors' work. In this case I did direct them. I do not, as a rule, report direct to the County Council. The inspectors themselves report to the County Council.

1887. (*Sir William Church.*) What length of time would elapse between your getting samples of beer in this manner and your being able to take action? Would you impound the beer or state that the beer was not fit for food?—About three days, I think, would elapse in most cases between the receipt of the sample by the analyst and the report to me with regard to its being arsenically free or not.

1888. Could you take immediate action against the seller at the end of those three days?—We did not, as a matter of fact. The policy the County Council laid down was that they should not take proceedings against any of the sellers in the first instance.

1889. Had you power to?—We had power to, but we could not have done so without estimating the quantity, and that would have taken longer. We did not trouble very much in the first instance about the quantity of arsenic present, but simply ascertained the fact that it was present in order to follow up the different breweries, and obtain particulars from the brewers.

1890. Would you have had power to seize the beer in the breweries?—Oh, no.

1891. What machinery would you have had to use to get hold of it?—We should have taken proceedings against the seller of the beer, not the brewer.

1892. And those you could have taken immediately?—As soon as it was ascertained that the beer was arsenical—certainly.

1893. Do you say you would have had to wait for the quantitative analysis?—It would have been wise to do so, in order to decide whether it was a case on which to take proceedings or not.

1894. Can you in your district, in the case of any prosecution under the Food and Drugs Act, act within a few days?—Yes; I do not know anything against it.

1895. (*Dr. Whitelegge.*) That depends upon the date of the analyst's report, does it not?—Certainly; it entirely depends upon that.

1896. (*Sir William Church.*) What is the length of notice with regard to the taking of proceedings?—I am afraid I cannot tell you what that is; I do not know.

1897. (*Dr. Whitelegge.*) You mean within two or three days. The analyst being prompt in making his report, you would be able to initiate proceedings?—Certainly. The Clerk of the Council would initiate proceedings.

1898. In what terms did the analyst report in these cases?—Simply with regard to the presence or absence of arsenic.

1899. What did you understand when absence of arsenic was reported?—That he did not find arsenic.

1900. Did you infer that there was no trace of arsenic?—Yes; he reported to me as to whether there was "a trace" or "a considerable quantity."

1901. Then he did not report in the usual terms that the sample was genuine?—No; for this particular inquiry it did not matter to me from that point of view whether it was genuine or not. It was simply a matter of whether it contained arsenic or not, in order that I might be able to follow up the investigation as rapidly as possible.

1902. Then he reported either that arsenic was present, that a trace of arsenic was present, or that there was no arsenic?—Yes.

1903. And where he reported that there was no arsenic you understood that none whatever was present?—Quite so.

1904. Did you give instructions to the analyst as to the method of dealing with those samples?—No, except the general instruction that we did not propose to take proceedings at that stage, and for that reason it was desirable to ascertain qualitatively in the first instance so as to get on as fast as possible with the work.

1905. So that if the analyses had been made on the ordinary lines the analyst would have required a longer time?—Yes.

Samples collected under F. and D. Acts independently of C.C.

1906. Was any independent action taken by the local medical officers of health?—In some instances. They communicated with me that certain cases had occurred and that they suspected certain beers. I suggested in certain cases that they should collect samples of those beers and send them to the county analyst.

1907. Have they power to do so under the arrangements made by the County Council?—Yes, they have power to do so. I think there is nothing to prevent their doing so; but, of course, the local authorities have to pay the expenses of the analysis. In this special case that was not done. We undertook to analyse all the samples.

1908. As a matter of ordinary practice, does the administration of the Sale of Food and Drugs Act in the smaller districts rest entirely with the county authorities?—Entirely.

1909. (*Chairman.*) That is the County Council?—Yes.

1910. A county borough is a borough with a population of over 50,000—is that so?—That is so.

1911. Is that the definition of a county borough?—Yes.

1912. (*Dr Whitelegge.*) They must claim county boroughship, must not they?—These boroughs were county boroughs originally by reason of their population. Of course, you may have a borough with a larger population than that, and it need not necessarily be a county borough unless they claim to be so.

1913. (*Chairman.*) But they can claim?—Yes.

Who appoints Public Analyst.

1914. Each county borough appoints its own analyst, independently of the geographical county in which it lies?—Yes.

1915. Has a municipal borough power to appoint its own analyst?—Yes. I do not know whether there is any regulation with regard to the population in that respect—I am not quite sure.

1916. I am told that a municipal borough which has power to appoint its own analyst has a population of 10,000 or over?—Quite so. That is probably it. We have only one example of that in which they have selected to appoint their own analyst.

1917. Where was that?—At Newcastle.

1918. Is that a municipal borough?—Yes.

Samples under F. and D. Acts must be taken from retailers

1919. (*Dr. Whitelegge.*) Were the whole of the samples taken from the retailers?—Yes.

1920. Have you power to take samples from brewers?—I do not think so.

No power to seize arsenical beer in breweries under P. H. Acts.

1921. (*Sir William Church.*) Supposing you had reason to think that the beer in the breweries was contaminated, under the Public Health Act, could not you take action?—I doubt whether we could. As the result of the analyses, 140 samples of beer having been analysed, 15 were found to be decidedly arsenical, and 7 slightly so. Eleven samples of glucose, brewing and other sugars, were analysed, and two samples of the glucose were found to be arsenical—both of Bostock's manufacture.

1922. (*Dr. Whitelegge.*) From what source were the samples of glucose obtained?—They were both obtained from brewers. On the occasion of my visits to the various brewers, I obtained a sample from two of them of the glucose they had been using.

Informal samples obtained from Brewers.

1923. That was informal?—Yes, quite informal; they need not have given them to me.

1924. (*Chairman.*) You visited the implicated breweries, I believe?—Yes, and the brewers very willingly gave me the information I wanted. I believe in most cases they were very active in withdrawing the contaminated beers.

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1925. Is there anywhere in Staffordshire a brewery where Bostock-brewed beer remains on the premises at the present moment?—Up till lately a quantity of beer did remain on the premises at least in one case, but I don't know whether at the present moment there is any. The reason was that the beer was retained in the hope of getting the duty refunded.

Arsenical beer remained undestroyed for the purposes of rebate.

1926. And in the meantime they kept it on the premises?—Yes, or it was locked up in their public-houses.

1927. (*Professor Thorpe.*) Why was it necessary to keep it for the purpose of obtaining a draw-back?—It was only kept, I suppose, in order that they might be able to establish the fact that a certain quantity had not been sold.

1928. But is there anything exceptional in that particular case. Why should the brewer not have called in the Revenue officer to measure the quantity and then proceed to destroy it?—The Revenue officer could not always come when he was called in; they had to wait for him to come.

1929. It was not because of any reluctance on the part of the brewer to destroy the beer, but because the official was not able to attend at the time?—That is so.

1930. (*Chairman.*) Was there any delay on the part of the Inland Revenue authorities in intimating whether or not the duty which had been paid would be refunded?—I believe so. I do not know whether they have intimated so even now. Quite lately they had not done so.

1931. Is not that unfortunate?—I think it is distinctly unfortunate.

1932. Did the brewers without exception afford you every information?—They did.

1933. Have you any further remarks to make with regard to it?—I should like to point out that in one instance this delay on the part of the Inland Revenue led to arsenical beer being sold, although it had been withdrawn by the brewer, the public-house keeper himself selling beer which had been condemned. If the brewer had had an intimation from the Inland Revenue Office that the duty would be refunded, he would immediately have destroyed that beer, and that could not have happened.

1934. Was this accidental on the part of the seller?—No, it was deliberate.

1935. (*Professor Thorpe.*) Why is it that you so confidently say that, if the Inland Revenue Office had expressed its willingness to pay the rebate, the beer would have been destroyed?—The brewers have told me that they were quite prepared to destroy the beer, but at the same time they did not want to lose more than was necessary, and as they could not get the duty refunded without proving the quantities destroyed, they had to wait until the Inland Revenue authorities satisfied themselves regarding that point.

1936. Inasmuch as the beer would have had to be destroyed sooner or later, I do not quite see why that necessarily caused the beer seller to put the beer back for consumption?—The reason why the beer seller put it back for consumption was because he was merely the tenant of a tied house, and by selling this beer he obtained profit from it which he otherwise would not have obtained; that it to say, the money obtained from the sale of this beer went entirely into his pocket.

1937. He was a seller in a tied house?—Quite so.

1938. Then he was not a free agent?—He had the instructions of the brewer not to sell this beer, and in the face of those instructions he sold it.

Prosecution under F. and D. Acts in Shropshire.

1939. (*Chairman.*) Was action taken against him?—Yes, action was taken under the Sale of Food and Drugs Act; not by the Staffordshire County Council.

1940. What was the penalty for that?—I do not know what the penalty was in this case. It would be a fine.

1941. (*Dr. Whitelegge.*) Do you know under what section the prosecution was taken?—No; it was in Shropshire this occurred.

1942. In cases where there was delay on the part of the brewer, and on the part of other persons, in destroying contaminated beer, were the local medical officers of health informed?—I do not think there was any delay on the part of any brewer in withdrawing arsenical beer; one did not find there was any delay.

1943. In the case of the brewer who retained the arsenical beer under lock and key, as I understand, pending the decision of the Inland Revenue authorities or a visit from their officer?—Several brewers did so, but the respective medical officers of health were not specially informed of that fact.

Dr. G. Re 13 Mar. 1

1944. And in the case of the retailer, was the action taken by the local authority, so that the medical officer of health was aware without any intimation from yourself?—Yes, in that case.

1945. Were the local medical officers of health informed which were the arsenical breweries?—Not specially, but I was in constant communication with them, and I think in every instance they did get the information.

Quantity arsenic in Staffordsh beers

1946. (*Chairman.*) Will you describe the results of the analyses?—Out of the 140 samples analysed 15 were found to be decidedly arsenical, and 7 very slightly so.

1947. (*Dr. Whitelegge.*) What do you mean by slightly so?—Under 1-20th of a grain per gallon. Eleven samples of glucose, brewing and other sugars were analysed, and two of the glucoses were found to be arsenical.

1948. (*Chairman.*) Were the eleven samples of glucose obtained from different manufacturers?—No, the two samples that were found to be arsenical were from the same manufacturer.

1949. Were some of the other samples from other manufacturers, or were all the eleven from different manufacturers?—They were all from different manufacturers, with those three exceptions. But they were not all glucoses.

1950. Glucose and brewing and other sugars?—Yes.

1951. There were only two samples of glucose or other brewing sugar from Bostock's?—That is so.

1952. And they were both found arsenical?—Yes.

1953. And there were nine samples from other manufacturers none of which were found to be arsenical?—That is so.

1954. What was the amount of arsenic found?—The amount of arsenic found in contaminated beers varied from "a trace," under 1-20th of a grain per gallon, to a little over half a grain. The 140 samples were collected from 28 different districts, and 140 distinct sources. They represented the beers of 90 brewers, including 26 samples of home-brewed beer.

1955. (*Sir William Church.*) That means the beer used by a publichouse where the publican brews his own beer?—That is so.

Arsenical beer alle to contai Bostock sugar.

1956. Not a beer brewed by private individuals?—No. In only one instance did we fail to trace the contamination of the beer to the use of Bostock's glucose.

1957. What brewery was that?—That was a brewery at Newport, in Shropshire.

1958. Did you succeed in finding the cause of the contamination?—No. I visited the brewery, and the brewer admitted having used Bostock's sugar, or having had Bostock's sugar on the premises 12 months previously, but he assured me that no glucose from Bostock's had been used within 12 months. Of course, it is just possible that it may have been, but if what he told me was correct, I cannot say how the arsenic got into that beer.

1959. (*Dr. Whitelegge.*) Was any examination made of the malt?—No, not in that case.

1960. (*Professor Thorpe.*) What were the materials used in the brewing?—He used glucose in brewing, and he told me what glucose he had been in the habit of using subsequent to Bostock's.

1961. What glucose was that?—He used two glucoses, one from Garton, Hill, and Co., and the other from Valentine, Todd, and Co.

1962. Do you know if those firms are actual makers of this material?—I believe Garton, Hill, and Co. are not makers.

1963. You know nothing about the other one?—No.

1964. What was the amount of arsenic found in that particular beer?—It was not estimated.

1965. Was it more than "a trace"?—It was returned as "distinctly arsenical," but the amount was not estimated.

1966. (*Chairman.*) And the origin in that case was not known?—It was not known. I should like to mention in connection with that case that the house where the beer was obtained was not a tied house, and although the publican said that the beer was obtained from this particular brewery it does not follow that it was so; it may have come from some other source.

1967. (*Professor Thorpe.*) It may have been brewed from Bostock's sugar?—It may have been. The only reason I had for saying that it was not brewed from Bostock's glucose was the assurance I had that the beer was obtained from the particular brewery in question; but there is just the possibility of its having been obtained from another brewery, because it was not a tied house. The publican said he did not obtain beer from any other brewery than the one I specified.

1968. (*Chairman.*) The Commission would like to have the names of the breweries referred to by the numbers in your statement?—I will supply them.

1969. In the table in your statement you give 667 cases. Is it probable that the numbers are under-estimated?—Yes, that is so.

1970. In many of the returns suspicious cases were not mentioned?—No, they were not.

1971. And many of those suspicious cases may have proved real?—They may have done so.

1972. Which were not included in this number?—That is so.

1973. How many fatal cases were there?—I believe it is possible there may have been two deaths.

1974. Two deaths out of the 667?—Yes.

1975. The 667 were all decidedly cases of illness?—There is no doubt about that.

1976. Severe illness?—Some cases were severe and some were slight.

1977. And all due to arsenic?—Yes.

1978. (*Dr. Whitelegge.*) To what causes were the fatal cases attributed?—Arsenical neuritis was said to be the cause in one, and in the other it was not returned as arsenical neuritis, but I had reason to suppose from a conversation with the practitioner that there was extreme probability of its having been so.

1979. What cause did he assign in the certificate?—I cannot tell you.

1980. Were there any cases of illness in Wolverhampton? I do not see Wolverhampton mentioned in your list?—I got returns from Wolverhampton, but they were all in the negative.

1981. So that, as far as your knowledge goes, there were no cases in Wolverhampton of arsenical poisoning?—As far as my knowledge goes. I may say with reference to that that later on I believe cases that were supposed at the time of my enquiry not to have been arsenical poisoning were found to have been so.

1982. So that those also would need to be added to the list to make it complete for the geographical county?—Quite so; but that I have no real evidence of.

1983. (*Chairman.*) Many of those cases were reported as arsenical neuritis?—Yes.

1984. That is a new name, not known before the recent scare, is it not?—That is so.

1985. Is it likely that there may not have been mistakes, the thing being so new?—I do not think so.

1986. Mistakes in calling it arsenical neuritis?—I do not think so.

1987. Many different practitioners made the returns?—Yes; I cannot tell you how many practitioners made the returns to the medical officers of health locally; but I had returns from all the medical officers of health, namely, 54, that is, 50 in the administrative county and the four medical officers of health of county boroughs, and 44 out of 48 hospital physicians.

1988. Do you think all of them had sufficient knowledge of the symptoms to be able to declare that it was arsenical neuritis?—Yes, especially in view of the prominence given to the question in the medical journals.

1989. (*Sir William Church.*) I suppose we may take it that many of the cases of illness which have been returned lately as arsenical neuritis would have been returned a year ago as alcoholic neuritis?—Yes, probably, or not recognised one way or the other—very mild cases.

1990. We have had evidence before us of what was called alcoholic neuritis being a very prevalent condition in Manchester and Liverpool for some time. Do you know whether that was the case round Lichfield, for instance?—I have no information with regard to that.

1991. Nor in any part of the county?—I have discussed the question with some members of the staffs of the two large hospitals, namely, in the north and south of Staffordshire.

1992. Lichfield and Bilston seem to be the places where the greatest number occurred?—But there were no hospitals there; those cases were reported by private practitioners.

Breweries implicated in Staffordshire.

1993. (*Chairman.*) In your table you gave a number of cases for each district, and the suspected brewers or breweries. Are we to understand that the beer of those breweries, or some sample of beer from those breweries, was found arsenicated in every instance except those referred to by the asterisks?—That is so. I think there can be no question that brewery No. 5 had at one time brewed arsenical beer, because cases followed that particular beer throughout all parts of the county; but we never succeeded in obtaining a sample which on analysis proved to be arsenical.

1994. (*Sir William Church.*) Was No. 5 the brewery which had ceased to use Bostock's during the year?—No; that is not the same brewery. This No. 5 brewery, I think, must have been using Bostock's glucose; at any rate, I feel satisfied that it had been brewing arsenical beer, and had withdrawn all the beer very actively before we started the inquiry.

1995. (*Chairman.*) No. 5 is the only brewery to which the asterisk applies?—Yes.

1996. In every one of the others connected with the cases beer was found arsenical?—That is so, except where there is a query.

1997. A query, and no name mentioned?—Yes.

1998. But in every case of a number mentioned arsenic was found in the beer in that brewery?—Yes, that is so.

1999. (*Sir William Church.*) How do you explain the freedom, or comparative freedom, of Stafford itself? I see only four cases are marked in Stafford?—It so happens that the breweries supplying Stafford were not implicated breweries. The four cases in Stafford were connected with an implicated brewery in Lichfield, that is to say, it was the Lichfield beer.

2000. Stone rural appears to have very few cases as compared with Stone urban?—The reason of that, I think, would have been probably explained had we found arsenic in the beer of brewery No. 5, which has a large sale in the urban district of Stone. We did find an arsenical beer brewed by another brewer in Stone, only the quantity of glucose used was not sufficient, from the experience in other districts, to have caused the illness there, and that is my reason, together with the fact that cases were dotted about all over the county connected with No. 5 brewery, for saying that I feel certain that No. 5 brewery at one time contained strongly arsenical beer.

2001. Many of those cases in the rural districts were in houses connected with No. 5 brewery, tied houses, perhaps?—I do not say in the rural ristricts particularly.

Local distribution of cases

2002. (*Chairman.*) Which is Stone rural and which is Stone urban in your list?—The urban is the first one.

2003. Stone urban, 69?—Yes.

2004. Breweries 3 and 5?—Yes; and Stone rural is 2.

2005. (*Sir William Church.*) Would the houses in the rural districts be generally free or tied?—I think they are just as likely to be tied in the rural districts as in the urban.

2006. (*Professor Thorpe.*) What is the relative proportion between Stone rural and Stone urban as regards population?—The rural has about twice the population of the urban.

2007. (*Dr. Whitelegge.*) To what period do these figures relate?—Up to the close of the first stage of the enquiry—that would be the end of the third week in December.

Other cases since December 1900.

2008. Have you more recent figures?—I have more recent returns, which I mention under the head of "Further Inquiry." "After an interval of about four weeks circulars were addressed to most of the medical practitioners who had previously reported cases, and from the replies received it would appear that 60 of the original patients are still suffering from the symptoms. A few fresh cases are also reported by two medical practitioners, but from subsequent inquiry I am by no means satisfied that the cases were of recent origin."

2009. Was there any observable increase of neuritis in the death returns recently, to your knowledge?—

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Not to my knowledge; of course, I have not got the recent death returns, and in the reports sent to the County Council annually, by medical officers of health, the causes of deaths are frequently not fully classified.

Breweries using small quantities of Bostock sugar.

2010. (*Chairman.*) I see in the part of your précis which follows the table reference to "another and largely implicated brewery." Was this brewery in the Potteries district?—Yes. Perhaps I may refer to that paragraph more particularly, because it is rather instructive with regard to the quantity of arsenic which gave rise to the symptoms. "One remarkable, and from a clinical point of view, instructive fact, has been demonstrated by the inquiry in Staffordshire, namely, that whereas at least 67 per cent. of the cases were attributable to one implicated brewery, another and larger implicated brewery, supplying a much larger population, did not give rise to recognisable cases of illness calling for medical treatment. In the first case the quantity of arsenic per gallon of beer was found to be a little over half a grain, while in the latter case only 1-10th of a grain was found. In both cases it so happens that the quantity of glucose used to malt was 20 per cent., and the amount per gallon 5·1 and 5·6 ounces respectively, but, whereas in the former case one glucose only (Bostock's) was used, in the latter the brewer used a mixture of equal parts of three different glucoses, only one of which was Bostock's; thus, while the actual quantity of glucose used was very much the same in both cases, the relative proportion of arsenical glucose per gallon of beer was 5·1 and 1·8 ounces respectively, a proportion which is consistent with the quantity of arsenic found in the two beers. As it would appear, then, that thousands of persons, for an unknown period, had been drinking beer containing 1-10th of a grain of arsenic per gallon without suffering any effects sufficient to call for medical attendance, the question arises is this the first occasion on which arsenical beer has been brewed, and may not some illness have previously occurred which, in view of what we now know, may have been attributable to arsenical poisoning?"

2011. 67 per cent. of the cases, I see, were attributed to one brewery?—Yes; that brewery was at Lichfield, and was, no doubt, largely responsible for the cases in Lichfield urban and rural districts, and in Brownhills, and Cannock.

2012. (*Sir William Church.*) What is its number?—47.

Cases in Lichfield and neighbourhood.

2013. (*Chairman.*) I see there were 290 cases in the Lichfield district?—Yes, in the rural district. But in that and the adjoining districts which one may say are largely supplied with beer from that particular brewery, there were 434 cases.

2014. 434 cases in all supplied from No. 47 brewery?—Probably supplied. Of course, one cannot absolutely say. I have one or two figures which amplify the information I have given in that particular paragraph, which perhaps I may call your attention to. I have a shaded map (Appendix 7) here showing the actual districts. For example, in North Staffordshire the towns of Burslem, Hanley, Newcastle, Stoke, Fenton and Longton having a total population of about 220,000, there is a very large brewery supplying a great number of houses in that particular locality, and that beer was found to be arsenical.

2015. Largely arsenical?—About one-tenth of a grain per gallon.

2016. (*Dr. Whitelegge.*) What is the number of that brewery?—That is No. 6.

2017. No. 6 is the brewery that had the largest quantity of arsenic found per gallon?—No; brewery 47 had the largest quantity. We had only fourteen cases reported in that population of 220,000; whereas in the Lichfield district, including Lichfield urban and rural, Brownhills, Cannock, and Rugeley, there were 434 cases reported, although the population is only about 72,000. I do not know whether you follow me. The population in the case of the northern towns supplied by arsenical beer containing one-tenth of a grain per gallon is 220,000; the population in the southern districts supplied largely by beer containing half-a-grain per gallon is 72,000. In the former case we only had fourteen cases, and in the latter 434 cases. That is to say for every case that occurred in the larger area, 31 cases occurred in the smaller area.

2018. (*Chairman.*) Out of the whole 667, 434 were attributed to beer, which in certain samples taken at the end of last year was found to have half a grain of arsenic per gallon?—That is so. The case rate in the northern towns was ·06 per thousand, associated with 1-10th of a grain per gallon of arsenic, and in the southern districts 6 per thousand.

2019-20. (*Chairman.*) I understand you to say that is 6 per thousand associated with half a grain per gallon?—Yes. The ·06 per thousand refers to the 1-10th of a grain per gallon.

2021. (*Dr. Whitelegge.*) May we assume that the consumption of beer was approximately equal in each case per head?—That I cannot tell. I think, however, you may assume that, because the cases are mostly in the working-class population.

2022. Do you attach any importance to local conditions in either place?—I do not think so.

2023-4. (*Dr. Whitelegge.*) In the northern districts do we understand that the brewery which you have in mind supplied the greater part of the beer?—A very large part.

2025. The conditions were comparable in that way?—Certainly, broadly so they were.

2026-8. (*Professor Thorpe.*) Do you know whether that brewery which supplied mainly the North Staffordshire district, the beer containing 1-10th of a grain per gallon, supplies also other outlying districts?—Yes, it does.

2029. Largely?—Not nearly so largely as in the case of the North Staffordshire districts.

2030. (*Sir William Church.*) Is No. 6 Brewery among those in the list which are stated as suspected?—No, it is not. I did not feel justified in positively associating the small number of cases with that particular brewery. The omission is not a mistake. If I were to refer to the returns from the particular districts in that group in North Staffordshire I should probably find that there was not sufficient evidence in them to justify me in definitely crediting that particular brewery with the cases.

2031. (*Dr. Whitelegge.*) You mean no clinical evidence?—No clinical evidence.

2032. But the beer definitely contained arsenic?—Undoubtedly; and there is a very large sale for the beer from that particular brewery in that locality; but I do not think I had sufficient evidence in the returns to warrant one in attributing the cases to any particular brewery.

2033. (*Professor Thorpe.*) Did you learn that that firm used Bostock's sugar?—Yes. I know the exact proportions in which they did use that sugar.

2034. They used in addition other sugars, did they not?—They did; two other sugars. They are given in my notes. The quantity of glucose used in the case of the southern brewery with which the 434 cases are associated was 20 per cent.

2035. (*Chairman.*) 20 per cent. in the gallon?—No; 20 per cent. of glucose to malt, and the amount per gallon was 5·1 and 5·6 ounces respectively. That is to say, in the case of the northern towns 5·6, and in the southern towns 5·1. But in the case of the northern towns only one-third of that was Bostock's, whereas in the southern towns the whole of it was Bostock's. That being the case, the quantity of arsenical glucose used in the case of the southern towns was 5·1, and in the northern towns 1·8 ounces. And that is pretty consistent with the relative quantity of arsenic found in the two beers. It follows, therefore, that thousands of persons had been drinking beer for an unknown period containing 1-10th of a grain of arsenic per gallon without suffering any effects sufficient to call for medical attendance.

2036. You say "unknown." Have you any reason to believe it is limited to a certain time?—No. I should say mild cases might have been going on for a long period unrecognised.

2037. But the only special reason to suspect that there had been as much as 1-10th of a grain of arsenic per gallon for a considerable period is the fact that the brewery used Bostock glucose?—That amount was actually found in the beer in question at the end of last year.

2038. But it was traceable to the Bostock glucose?—Yes.

2039. Does any question arise with respect to that?—The question which arises is this: This is the first occasion on which arsenical beer has been proved to have been brewed and to have been the cause of illness. May not

some illnesses have previously occurred which, in view of what we now know, ought to have been attributed to arsenical poisoning?

2040. You put that as a question. Have you any view yourself? Can you contribute anything towards answering it?—Here is actually what has happened. For a certain length of time beer containing arsenic to that extent, 1-10th grain per gallon, has been consumed in large quantities by a large number of people, and until the recent scare it never has been noticed that any unusual illness occurred. But attention being directed to the matter, cases were recognised which probably would previously have been overlooked. It is quite possible that slight illnesses owing to arsenic may have been going on indefinitely.

2041. (*Sir William Church.*) Could you give us the returns from the figures of the Registrar of Deaths, showing the number of deaths attributed to alcoholic paralysis during the last five or ten years in the northern district?—I am afraid I could not; but I might obtain the figures.

2042. It would be very interesting to see them?—I could obtain them from the local medical officers of Health, but perhaps some of them would not have sufficient data. You can get them from the Registrar-General.

2043. Of course, it would be a very inaccurate return, but it would be useful and interesting?—I am afraid in some cases you would not be able to get saisfactory returns.

2044. Not from the death certificates?—You could get returns for an area corresponding with this area very closely from the Registrar-General's returns.

2045. But take the northern district, the one in which the attacks have been so few; could you not get it by an application to the Poor Law officers who attend the large workhouses and infirmaries?—You could get it from the workhouses, certainly.

2046. That would be of great interest and of a certain amount of value as bearing upon the increase of deaths attributed to alcoholic paralysis?—Yes; but you can get the actual figures from the Registrar-General's returns for an area corresponding very closely to the area under consideration.

2047. (*Chairman.*) Would that return show peripheral neuritis and alcoholic paralysis separately?—No; I should say they would be grouped under the same head.

2048. Did the ordinary peripheral neuritis occur in returns as a cause of death or of severe illness previous to this scare?

(*Sir William Church.*) Peripheral neuritis will occur, I think, under the Registrar-General's returns only since the year 1886. Under the head of peripheral neuritis are certain sub-heads, such as alcoholic, diphtheritic, and so on.

2049. (*Chairman.*) Then with regard to further inquiries, what course was adopted?—After an interval of about four weeks another systematic collection of samples was undertaken.

2050. (*Dr. Whitelegge.*) At what date?—At the end of the third week in January, and attention was specially directed to the public houses supplied by the previously implicated breweries, and as a result of this second collection, including 43 samples of beer, 10 of confectionery, and 5 of syrup, all were found to be arsenic free.

2051. (*Chairman.*) Do you know any case of confectionery or golden syrup that was found to be arsenical?—I do not know of any.

2052. At this recent inquiry you say not, but was there any at any previous inquiry?—No; we have not found any to be arsenical.

2053. (*Dr. Whitelegge.*) All were found to be free from arsenic, on the same understanding that you explained to us before?—Quite so.

2054. You understood that they were entirely free from arsenic?—Yes, I should say so—that no arsenic could be found; that is to say, analytically.

2055. No trace?—No trace.

2056. (*Professor Thorpe.*) You mean that the analyst so reported?—Yes.

2057. (*Dr. Whitelegge.*) In those terms?—Yes, in those terms. The terms were "Arsenic free."

2058. (*Sir William Hart-Dyke.*) Were those samples of confectionery you refer to taken from a large area, or were they taken from one town?—They were not taken from one town. I can give you the exact towns they were taken from, if you wish. They were taken from six different districts in North Staffordshire. *Dr. G. Reid.* 1st Mar. 1901.

2059. They were taken from a sufficiently large area, at all events, to be a real test as to the likelihood or danger of finding arsenic in confectionery?—I should not say it is a real test, but it is a very fair test.

2060. A fair test so far as that portion of the inquiry is concerned?—Yes. The collection of these samples will be continued for some time.

2061. (*Professor Thorpe.*) I suppose you have not been able to trace the manufacturer of this confectionery as in the case of the glucose, have you?—One could trace the manufacturer, of course.

2062. Would the retailers of the confectionery be able to tell you the wholesale houses with whom they dealt?—I do not know. If any of these samples had been found to be arsenical we should have followed them up, and ascertained those points, if possible; but as they were free from arsenic no further notice was taken.

2063. It might happen that in such districts as you are speaking of there are comparatively few manufacturers engaged in supplying them?—Quite so.

2064. Is any confectionery made in the district?—In one district, I believe—in Newcastle.

2065. Is it a large works?—No; quite a small works.

2066. (*Chairman.*) At our last meeting Mr. Jones, the Staffordshire public analyst, who has tested these samples, told us that he used the test of the Brewers' Expert Committee, which would detect 1-20th of a grain per gallon, and which might in his own hands, or very carefully worked, detect 1-36th of a grain per gallon. Do you understand that "arsenic free" means that the substance does not contain as much as 1-20th?—My information from the analyst is that it is well under 1-20th. Meaning of 'Arsenic free" beer.

2067. Might it contain as much as 1-36th of a grain per gallon, and be returned as "arsenic free"?—I should say not.

2068. You think it is not as much as 1-36th—that is a good deal less than 1-20th. You think that even as small a quantity as 1-36th could be detected?—I am not prepared to say what quantity could be detected. In the returns the county analyst sent me in some cases the term used was "a mere trace." I do not exactly know what he would mean by "a mere trace"; but I should take it to be well under 1-20th.

2069. 1-36th would be "a trace," at least?—I do not know whether he gave you any information with regard to that. I should not like to say what chemically would be considered "a trace."

2070. When he returned a substance as "arsenic free," he had to ascertain that it contained less than 1-36th?—Yes; I should say so, from what you have told me.

2071. Perhaps it might have contained 1-50th, and be returned "arsenic free"?—I cannot tell you that.

2072. You are not quite sure about that?—No.

2073. (*Dr. Whitelegge.*) If an analyst told you that a sample of beer contained 1-50th or one 1-40th of a grain, in what light would you regard it—as harmless?—Of course, it depends upon the quantity consumed. In some cases the people drink a gallon of beer a day, or more.

2074. If it contained 1-20th of a grain, I understand you would regard it as dangerous, and you would take certain action in the way of stopping the supply?—Yes.

2075. And if it contained 1-50th or 1-40th, would you take any action?—I should be in rather a difficulty as regards advising the Council upon that point. Of course, one would like to be in a position to say that beer shall not contain any arsenic. If it is impossible that beer shall be arsenic free absolutely, it is desirable to arrive at some sort of standard, but what that standard shall be I should not like to say at the present moment. Administrative need for standard test for arsenic in beer.

2076. (*Chairman.*) As a medical question, do you think that a person might take 1-50th of a grain of arsenic per day in food or drink without being injured? 1-100th of a grain, I believe, is a common dose in medical treatment?—Yes, probably.

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2077. That might be given two or three times a day?—I do not think it is desirable that anyone should take any quantity of arsenic, even that quantity, regularly.

Effect of small quantities of arsenic in beer.

2078. Would you regard 1-50th of a grain per gallon per day taken unknown in food, and from day to day, as dangerous to health?—I would not say it was dangerous to health. The probability is that you would not find any symptoms from it.

2079. Not if even a dose of that amount were continued from day to day for weeks or months?—I should doubt whether any symptoms would be produced. It is a very difficult question to answer.

2080. (*Professor Thorpe.*) I suppose you are guided to that opinion by what you have told us as regards the comparative infrequency of any cases arising in the North Staffordshire towns where the beer has had as large a quantity as 1-10th of a grain?—One does not know to what extent individuals may have partially suffered without realising that there was much the matter. Some cases have come before medical men, and they must have been suffering, but it does not follow that others may not have suffered in milder degree and gone on suffering without seeking medical advice.

2081. There is a great difference between one-tenth and one-fiftieth of a grain?—Yes, and there is a great difference between one-tenth of a grain and half a grain.

2082. (*Dr. Whitelegge.*) But the 1-20th of a grain has now ceased, has it not? There is no more beer containing 1-10th?—No; it would seem that there is not.

2083. But if it had continued indefinitely you might have anticipated further mischief?—Certainly. I think probably it did cause mischief, more than we know of, only not sufficient in the absence of any suspicion to direct attention to it.

Illness of brewery hands.

2084. (*Chairman.*) Do you think many of the patients drank as much as a gallon a day? You have returns of the quantities admitted to have been drunk?—In some cases.

2085. In some cases there was as much as a gallon a day consumed?—Yes, especially among the brewers' assistants, and in the case of two breweries almost without exception all these assistants were ill.

2086. (*Sir William Church.*) Whom do you mean by brewers' assistants?—Carters, and other people of that sort.

2087. You mean workmen, employees?—Yes.

2088. (*Chairman.*) With that quantity of liquid 1-50th of a grain per gallon, or its equivalent in Fowler's solution, would be detrimental?—Really, I am afraid I cannot say whether it would or not; it is a matter of experience.

2089. A great quantity of liquid would carry it off unabsorbed?—Possibly to some extent.

Minute quantities of arsenic in beer undesirable.

2090. Still, it is clearly a danger to have beer containing 1-50th of a grain per gallon?—It is certainly distinctly undesirable.

2091. Another sample of the beer is suspected as having caused a recent case of illness, is it not?—Yes; this was forwarded to me by a District Medical Officer of Health in consequence of a suspicious case of illness, arsenical poisoning, having occurred where this beer was being drunk, and the result of the analysis was that it contained an appreciable, though not a large, amount of arsenic. Further enquiries showed that this beer had been purchased in October, and that the retailer, the seller, obtained it from one of the brewers who was originally implicated. So it was traced back to the original trouble, and was not of recent origin.

2092. (*Sir William Church.*) You have no idea what an "appreciable amount" means?—No. I do not know; it is the county analyst's expression.

2093. Is this the same county analyst who used the term "a trace"?—Yes.

2094. An "appreciable quantity" would mean "a trace"?—I do not believe it would be much more than "a trace," but certainly not a large quantity, or anything like it.

2095. (*Professor Thorpe.*) Inasmuch as the analyst himself used it, I may point out that he would use it in a technical sense. "A trace" is an amount which the balance could not detect; by an appreciable amount" it meant a quantity which the balance will detect?—I do not know whether we may conclude that that was so in this case.

2096. Therefore it would be something larger than 1-20th of a grain?—That I cannot say. If the word "appreciable" is used in that sense it probably would be so.

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(*Professor Thorpe.*) It would be something larger than 1-20 grain.

2097. (*Chairman.*) If you desired to measure the amount, the large quantity of liquid in which it was suspended would be evaporated away?—I believe so.

2098. So it is only a relative term, after all? If it is there at all it is appreciable by taking a sufficiently large quantity of the substance?—Yes, I suppose so.

2099. (*Professor Thorpe.*) But in so far that all these were made, as we have been informed, by the method described by the expert, they were all made on the same comparative amount; that is to say, the actual amount of beer taken in each case would be the same?—I do not know what method Mr. Jones adopts at all.

2100. These are samples taken under the Sale of Food and Drugs Act, I suppose?—No; this particular sample was sent to me by a Medical Officer of Health, who obtained it from the attendant on the patient. The sample was sent to me, and as it appeared the case was associated with the beer, I sent it to the County Analyst for his report upon it.

2101. You had the sample?—Yes, I had it; but it was only 24 ounces.

2102. So you know the quantity which was used?—Yes.

(*Professor Thorpe.*) The amount was evidently so small that the analyst could not do very much with it.

Later enquiry by M.O.H.

2103. (*Dr. Whitelegge.*) Will you tell us about the circulars that were sent to medical practitioners?—Circulars have also been addressed in the second enquiry to most of the medical practitioners who had previously reported cases, and from the replies received, it appears that 60 of the original patients are still suffering from symptoms. A few fresh cases are also reported by two medical practitioners, but from subsequent inquiry I am by no means satisfied that the cases were of recent origin. With reference to that last remark, I inquired especially into these new cases, and I found that they would not have been recognised as cases at all had the patients not consulted a medical attendant for some other ailment, and in the course of that consultation symptoms were discovered pointing to arsenical poisoning. But it is by no means certain when these symptoms made their appearance.

Duration of illness.

2104. Do you think that the mischief is at an end now?—Yes, I think so.

2105. Do you intend to make any further inquiry with regard to the cases?—I do not think of doing so at present, at any rate.

2106. You do not think that there is anything to be learned?—I think not.

2107. If any inquiry were made, would it, in the light of your experience, be more proper to address it to the Medical Officer of Health or the practitioner?—I should address it, I think, to the Medical Officers of Health, because they took the thing up actively, and inquired from local practitioners. If I addressed it to the medical practitioners, I think I should get fewer returns. I got very full returns indeed. In some cases the local Medical Officers of Health drew up special circulars and circulated them throughout their own districts. I had very full returns from the districts by doing it in that way. Of course, there would not be the same urgency in another inquiry, and it might be well to communicate direct with medical practitioners. But in this case time was of importance. We wanted to arrive at the facts as soon as possible, and we thought the quickest way would be to communicate with the medical officers, and not with individual practitioners, except in the case of hospital staffs.

2108. By hospital staffs I suppose you include the staffs of workhouses and infirmaries?—Yes.

Glucose should be made from brimstone acid.

2109. (*Chairman.*) Can you give the Commission any suggestions with reference to preventive measures?—I have given three suggestions. First of all, I think no glucose or invert sugar should be manufactured with sulphuric acid unless the acid has been made from sulphur, and is free from arsenic. Further, that the brewers should obtain a guarantee to that effect from the sugar manufacturer with each consignment.

2110. Do you not think that sulphur acid guaranteed freed or free from arsenic might be allowed even if it was made from pyrites?—I do not think so.

2111. You think the guarantee of purity would not be sufficient?—No, I do not think so. That would involve the risk of its not having been purified.

2112. (*Dr. Whitelegge.*) Would you suggest any guarantee from the brewer to the seller?—I think that would be a desirable thing as well.

2113. (*Chairman.*) You would not impose any conditions against the use of glucose, except what you would impose upon all the ingredients—that is to say, that they should be arsenic free?—That is so.

2114. Have you any information as to the malt itself being arsenical?—I know that samples of malt have been found to be arsenical, but I have not sufficient information upon the subject to be able to give any evidence with regard to it.

2115. But you think the brewers should be obliged either to test themselves, or to take means of being quite sure that the ingredients they put into the brew should all be arsenic free?—Yes, I think so.

2116. Do you think brewers, besides having a guarantee from the persons who supplied the material, should themselves also make tests?—I hardly think that would be practicable—I mean in the case of very small brewers. The number of packages of the article received would be so great that it would involve a considerable amount of analytical work, and I do not think the small brewers would be able to do that.

2117. (*Sir William Hart-Dyke.*) As not possessing each their own analyst; is that your point?—Yes.

2118. (*Chairman.*) You think that the Inland Revenue Department could help?—I think that the Inland Revenue Department should be called upon to exercise control over brewing materials by its being made part of the routine duty of the Excise Officers to see that the guarantees are obtained, and to periodically collect samples for analysis by the Somerset House officials. That, I think, would be a very valuable addition to the precautions. It would not necessitate the multiplication of inspectors; and, as these officers have to be there in any case, and as the department has the necessary machinery available, it would be a very simple plan to adopt.

2119. (*Dr. Whitelegge.*) So far as power is concerned; but I suppose you would regard it as more or less an accident that the recent mischief has been in connection with beer, and not in connection with other food products into the composition of which glucose enters?—Yes.

2120. The precaution you suggest on the part of the Inland Revenue would only apply to brewers?—Yes.

2121. (*Chairman.*) Does the Inland Revenue Department take charge of the hops used?—There is no reason why they should not.

2122. At the present time do they do so?—I am not aware what they do—I do not think they do.

2123. You say that the brewers should obtain a guarantee from the sugar manufacturer to the effect that it is arsenic free: you would not limit that to the sugar maker alone; would you not have a guarantee from the maltster?—That might be desirable as well.

2124. And from the purveyor of hops—Yes; I would make it apply to brewing materials.

2125. In connection with the sanitary authorities under the Sale of Food and Drugs Act, have you any suggestions to make?—The only suggestion that I have to make is that I think it would be desirable that the Food and Drugs inspectors should have additional powers enabling them to seize contaminated beer.

2126. (*Dr. Whitelegge.*) Your inspectors?—Yes.

2127. Not the inspectors of the local authorities?—No. It depends upon how the Act is worked in the county. In some cases there is a considerable amount of work done by the local authorities in that direction, but in Staffordshire, at any rate, it is done practically entirely by the County Council.

2128. You would say that any inspector authorised to take samples should have the power not only to take samples, but to seize?—Yes.

2129. Are you thinking of seizure in the case of beer on the retailer's premises, or upon the brewer's premises?—I am thinking of it in connection with beers upon the retailer's premises, because the Inland Revenue Department ought to have control of the brewers.

2130. How do you suggest that the inspectors should identify the beer which he would seize in the retailer's premises, after analysis is complete, as being the same as that from which he took the sample?—That would be a very difficult matter. The fact of having seized a sample in a certain house would direct attention to a certain brewery, and special steps might be taken on the part of the Inland Revenue Department to ascertain whether any beers contained arsenic, or that there was arsenic in any of the materials. *Dr. G Reid.* 13 Mar. 1901.

2131. Are you thinking of seizure under the provisions of the Public Health Act?—The same sort of thing.

2132. Would the inspector, as the law stands at present, have power to seize on the premises of the retailer?—I do not think so.

2133. If he has taken a sample of beer which proves on analysis to be contaminated, and he can identify that sample with a stock, would that bring the case within his powers under the Public Health Act?—I do not think so, but I do not know.

2134. Are those the powers you want?—Those are the powers we want.

2135. (*Sir William Church.*) You do not yourself think that it would be a sufficient safeguard if the sulphuric acid was sold guaranteed pure, do you?—From the public point of view I do not think so.

2136. But if it was made from sulphur you would require a guarantee, would you not, that it was pure?—Yes, certainly. Advantage of acid from brimstone.

2137. (*Chairman.*) With reference to the Inland Revenue Department, there would be no check upon the sulphuric acid used in the manufacture of other articles of food or drink, would there?—No, there would not.

2138. Under the Sale of Food and Drugs Act would the sanitary authorities be a sufficient protection to the public against arsenical sulphuric acid being used in other things than beer?—I think so.

2139. (*Sir William Church.*) What is your reason for thinking that there would be a much greater safeguard if only acid from sulphur was allowed to be used in the preparation of food products?—Because I understand that sulphuric acid manufactured from sulphur is not likely to contain arsenic.

2140. But it may, may it not?—Well, I suppose it might, but it is not likely to.

2141. Would common sulphuric acid that had been purified be likely to contain arsenic?—No; I believe it can be purified, but then that involves the necessity of purifying.

2142. (*Sir William Hart-Dyke.*) You mean the double process in the one case and the one process in the other?—Yes.

2143. And there would be greater security in the one in the form of guarantee than there would be if the cleansing process were necessary?—Yes, that is my idea.

2144. (*Chairman.*) The mere guarantee of Sicilian sulphur would scarcely be enough, would it?—I am not sufficiently familiar with the process to be able to say yes or no to that; but I am simply taking it for granted that sulphuric acid made from sulphur is not likely to contain arsenic, whereas it is very likely to contain arsenic if it is made from pyrites.

2145. But in every case the sulphuric acid itself must be tested, whether made from Sicilian sulphur or from pyrites?—Yes, certainly.

2146. (*Sir William Hart-Dyke.*) Would you go so far with regard to this future security for the consumer as to have a penalty inflicted on any manufacturer who used pyrites for manufacturing sulphuric acid for food or for brewing purposes?—Certainly I would, if it could be shown that he knew that the sulphuric acid was intended for that purpose. There ought to be a penalty attaching to it.

2147. (*Chairman.*) Do you not think that sulphuric acid should be guaranteed whether it is intended for food or not; that if it is to be freely sold it is to be guaranteed that it does not contain quantities of arsenic?—Sulphuric acid is used largely for other purposes in which it does not matter whether it contains arsenic or not.

2148. Would it be safe with regard to manure to have a large quantity of arsenic in sulphuric acid; might it not get into the roots of turnips and other things?—That I cannot express an opinion about.

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2149. (*Sir W. Hart-Dyke.*) Would you suggest that officers of the Inland Revenue should periodically collect samples and analyse them?—I do.

Analyses for arsenic should be systematically made by Inland Revenue.

2150. Not for the purposes of the Inland Revenue so much as for the purposes of the protection of the consumer?—Yes.

2151. But would you not go a little further, and suggest that there should be a constant process of analysis of samples going on?—It would be rather difficult to know where to stop. I think a check of this sort would be sufficient to prevent the practice. I should say it would be hardly possible to analyse every sample of brewing material obtained by the brewer.

2152. It would involve great expenditure?—Yes; it would involve great expenditure and a large staff of inspectors.

2153. You think that the fact of it being generally known by sugar makers and brewers—all those connected with glucose, whether in the manufacture of beer or other articles of consumption, such as confectionery—that these constant analyses were going on at headquarters by the Inland Revenue would in itself cause much greater care to be used in the future than in the past?—Undoubtedly.

2154. The fact that these analyses were constantly going on, and it being known that the officers were so employed, would be a deterrent?—That is my experience under the Sale of Food and Drugs Act. The larger the number of samples collected, the less the adulteration.

2155. That is your experience of the working of the Sale of Food and Drugs Act?—Yes.

Use of brimstone acid.

2156. (*Professor Thorpe.*) Do you know what the relative proportion of oil of vitriol made from pyrites or from sulphur is at the present moment?—No, I do not.

2157. Would you be surprised to learn that 98 per cent. of the oil of vitriol made at the present time is made from pyrites?—Very likely.

2158. Would you be surprised to learn that the purest form of oil of vitriol used in chemical laboratories for testing is made from pyrites?—That may be so.

2159. Is it not also a fact that the greater portion of glucose made and certified to be free from arsenic is made from pyrites acid?—That I cannot tell.

2160. If it were shown to you that by far the larger proportion of glucose and invert was made from pyrites acid purified from arsenic; that such products have not been known to contain arsenic, or have not been found to contain it, would you think, under those circumstances, that sufficient cause had been made out for disturbing the practice of these manufacturers?—I think so, certainly.

2161. Why?—Simply because the public are entitled to have the assurance that every precaution will be taken in the future, and they would not have that assurance if they realised that a substance used in the manufacture was prepared in a manner which necessitated a process of purification being carried out before it could be used with safety.

2162. What would happen in the case of sulphuric acid manufactured from sulphur which contained arsenic?—Of course, that would be ascertained before the acid was sent out, but there is considerably less likelihood, I understand, of an accident of that sort occurring in the case of acid made from sulphur than when made from pyrites.

2163. But if you were told that every sample of sulphuric acid made from sulphur contained arsenic, and that the amount of arsenic was so small that there would be no necessity for it to be purified, would not a greater evil be produced by the oil of vitriol made from sulphur than by oil of vitriol which had been designedly purified?—In the former case arsenic would be present in such minute quantity that it would not be detectable when so largely diluted in the brewing process.

2164. Perhaps you do not know sufficient of the occurrence of arsenious oxide in native sulphur to speak on that point?—No.

2165. You do not know that from time to time "pockets" containing arsenious acid are met with in native sulphur?—That may be so; but I cannot say.

2166. You do not know, I suppose, that a large quantity of sulphur is now recovered, and could be used in the manufacture of oil of vitriol?—Recovered from what?

2167. Recovered as a by-product?—No; I do not know that.

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2168. And that as a by-product it may contain arsenic?—I do not know.

2169. (*Chairman.*) You think it would not be safe to trust to Etna never giving us any sulphur containing arsenic?—Probably not.

2170. So the ultimate test must be the purity of the acid given out?—Yes.

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2171. (*Professor Thorpe.*) What amount of supervision does your suggestion in your own mind entail? What amount of supervision, say, on the part of the Inland Revenue officials, is included? What amount of analysis do you suggest? Is everything that goes into a brewery to be analysed by the Inland Revenue officials, in your opinion?—Certainly not.

2172. What precise extent of analytical supervision are you thinking of?—To the extent which is usually carried out in well administered districts under the Sale of Food and Drugs Act.

2173. You mean, then, an occasional check sample?—More than that; I mean periodical collection.

2174. Do you think that if analyses of samples of brewery products were taken of the number and quantity of samples taken under the Sale of Food and Drugs Act, that the volume of food taken as samples should have the same relation to the food consumed as under that Act?—I suggest more than that, because the reason that samples are not taken in relatively larger number is because of the enormous work which would be involved in the case of food. Considerably less work would be involved in the case of breweries for this particular purpose.

2175. Would there be any difficulties arising from the fact that glucose or invert and other brewing materials generally come in every day in large quantities in any big concern?—Yes.

2176. Is it your contention that every one of those articles should be tested by an Inland Revenue officer?—Certainly not.

2177. What proportion should be tested, in your opinion?—I am afraid I cannot tell you beyond saying that tests should be made periodically. The fact that samples will be taken periodically, when known, will be a wholesome deterrent, and I would suggest also that the officer should inquire into the guarantee accompanying each lot of materials supplied.

2178. I agree with you that some central authority, say—the Inland Revenue Department, might be called upon to ascertain that the system of guarantees was properly enforced, but as an administrative matter—and I speak with some knowledge of the practice of breweries and of the volume of produce dealt with by them—I venture to say that anything like a check by a systematic examination by Inland Revenue officials only would be absolutely impossible?—Well, from the point of view of food and drugs, we may take into account the enormous volume of milk consumed in the country and sent from different centres into various parts. The actual adulteration of milk can be largely regulated by the number of samples collected in a county. Surely that would indicate that supervision in the case of brewers directed to the materials they use would at any rate keep the subject before them and prevent any recurrence of this present catastrophe in the future.

2179. Your illustration in regard to milk is a little unfortunate, because I have been sitting upon a committee which has had this question as to standards regulating the milk supply before them, and we obtained a large volume of evidence which went to show that the system of inspection, although in some cases apparently adequately carried out, has not acted to the extent you say, that is to say, it has not prevented the adulteration of milk?—That is not my experience, at any rate; because we have tested it more than once, and have found that the relative frequency of attempts at adulteration is lessened by the frequency of the demand for samples.

2180. No doubt there is some relation between the two; the more vigilance is exercised, the less adulteration is practised?—Yes; but in that case it is an adulteration upon which you must, or you may place a limit; but in this case the question is one of the presence or absence of a material. Also in the former case the adulteration is a deliberate act, whereas in the latter, so far as the brewer is concerned at any rate, it is an accident.

2181. You quote that as an evidence that a large num-

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ber of analyses did act as a deterrent in checking adulteration?—Yes.

2132. But I venture to say from what I have just told you, that the evidence we had shows it is not necessarily so?—I am surprised to hear that.

2133. If you read the report of that Committee you will see that in spite of the activity of the officers the amount of adulteration which continued in milk was very large?—So one would infer from that that it was advisable not to have a system of sampling?

2134. (*Professor Thorpe.*) I do not say that; but there is other machinery.

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2135. (*Dr. Whitelegge.*) What size of samples do you take in the case of beer?—As a rule, they have taken, I believe, an ordinary quart sample.

2136. Has that been found sufficient for the purposes of analysis?—I believe so—for the purpose of ascertaining the presence of arsenic. I do not know whether Mr. Jones required a larger quantity for quantitative tests; I cannot tell you.

2137. Have you given any instructions with regard to that?—No.

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2138. In the action you have taken, have you worked under official instruction of any kind?—Only under the instructions of my own council.

2139. Not under the instructions of any Government department?—We had a communication from the Local Government Board, suggesting that we should make an inquiry into this matter; but we had already proceeded with the inquiry at least a fortnight before that suggestion arrived.

2190. Was that the circular of the 11th of December?—Yes, that would be so.

2191. Was that sent to you officially, or to the County Council?—To the County Council, officially.

2192. Apart from that, have you had any instructions?—No.

2193. And I understand you did not make any report upon that subject to the Local Government Board?—No, not officially.

2194. Have you made a report to the County Council?—Yes, I have. A copy of my report to my Council was forwarded to the Local Government Board by the clerk of my Council I believe, and I forwarded copies to the Medical Inspectors of the Board.

2195. Upon what date, approximately, did you begin to take action with reference to arsenic in beer?—I brought it before my committee on the 1st of December.

2196. At that time, had any action been taken within the county by that authority?—No. *Dr. G. Reid.* 13 Mar. 1901.

2197. Was action being taken in the county boroughs?—Action was taken by the county boroughs subsequently, but I do not think at that time any action had been taken by them. By Borough and other local authorities.

2198. So that the initiative fell upon you?—Yes, it did.

2199. And at the later stages action was taken in the county boroughs?—Yes.

2200. But not by any local authorities—I mean smaller local authorities?—No; not by the smaller local authorities; not that I am aware of. Later on, in the case of some local authorities enquiry up to a point was made, but in most cases it was thought that the steps taken by the County Council were sufficient without any action locally.

2201. I understand that you have no direct authority over the inspectors who take samples?—No.

2202. You do not give instructions to the public analyst?—No.

2203. Were you acting in concert with him in the action you took?—Certainly.

2204. Have you any direct authority over officers of the smaller local authorities? You say you made certain suggestions to them. I take it they were merely suggestions?—Yes; suggestions only, made with the approval of my committee; I had not direct authority.

2205. Can you tell us anything as to the practice of the brewers in Staffordshire with regard to requiring a warranty? Has it been their practice to require a warranty previously?—No; I believe not.

2206. Has it been their practice to examine for arsenic?—No.

2207. Are any of them taking action at the present time with regard to that?—I believe so.

2208. Are they requiring warranties?—They are analysing for arsenic, and are obtaining and giving warranties.

2209. Brewers are analysing for arsenic, you say?—Yes; I believe they are. They are having samples submitted at the present time for analysis.

2210. In the absence of any further exercise of supervision by the Inland Revenue officers, would it be possible for the officers of any local or county authority to exercise control over brewers in the same way?—Yes; it would be possible if they had the power. Local authorities might be given power of control as regards purity of beer, but have not such power now.

2211. But not under the present powers?—No; not under their present powers.

Dr. Thomas Stevenson, called; and Examined.

2212. (*Chairman.*) You are Vice-President of the Chemical Society and of the Institute of Chemistry?—Yes. *Dr. T. Stevenson.*

2213. And lecturer on Forensic Medicine at Guy's Hospital?—Yes.

2214. And Scientific Analyst to the Home Office?—Yes.

2215. You have made a study of toxicology for nearly forty years?—Yes.

2216. You have analysed for the Home Office?—Yes, for nearly thirty years.

2217. And you have paid special attention to arsenic?—Yes.

2218. Clinically, pathologically, and analytically?—Yes.

2219. And you went to Manchester early in the epidemic?—Yes. I went to Manchester on the 28th November last. I inspected the dead bodies of two women, Dyer and McCabe, in the Crumpsall Mortuary, I saw and examined a considerable number of women and men in the Crumpsall Infirmary, I arrived at the conclusion fro the examination of these patients that they were suffering from chronic arsenical poisoning, and I also formed the opinion from the inspection of the bodies of the two women, and hearing their symptoms from the medical officer, that they had probably died from arsenical poisoning.

2220. Had you heard of the suspicion that had been raised a short time before the 27th November?—Yes. Dr. Dixon Mann saw me in London on the 23rd November, and I went to Manchester knowing that arsenic had been found in the beer, and I had heard during the intervening days a good deal about the epidemic. I went round the Crumpsall Infirmary with your Secretary here—he was present—and Dr. Reynolds and the resident medical officers, who showed me many of the patients, and took me to see the dead bodies whose viscera I was asked to analyse. Then, at the request of the other members of the Brewers' Committee, and at the request of the solicitors to that committee, I was specially charged with the analysing of the viscera of the patients alleged to have died from arsenic. The matter being urgent, I obtained portions of the viscera of the two women, whose dead bodies I had seen, from Dr. Dixon Mann, and returned to London on the 28th, leaving my fellow-Commissioners to conduct the local investigations. Subsequently I obtained, through the coroners of Manchester and Salford, through the solicitors of the Brewers' Association, the viscera of three other women who were alleged to have died from arsenical poisoning. I ascertained from the medical officers of the Crumpsall Infirmary and from Dr. Buckley, who was a fellow-member of the expert committee of the brewers, a knowledge that all the five women whose dead bodies I had examined had been drinkers, and that three of them drank beer largely. Taking the dead bodies of the two women, Dyer and McCabe, the histories of their symptoms and the post-mortem appearances externally as seen by myself, such as pigmentation, and the rashes, and the excessive accumulation of epithelial scales on various parts of the body, all pointed to arsenic as being the cause of death. In

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four of these bodies out of the five I found arsenic in the viscera. In one case only was it in a notable amount; in three other cases the amounts were what I may term minimal. One of the five women, Alice Booker, died six days after ceasing to drink beer. I had 13½oz. of her viscera.

2221. Which viscera was that?—The abdominal viscera: liver and intestinal canal. In Alice Booker a portion of the liver, kidney, spleen, 1oz. of the brain, formed the viscera that I examined.

2222. 13½oz.?—Yes.

2223. Is that ounce avoirdupois?—Yes.

2224. Was that the total weight, 13½oz.?—Yes; the total weight I had was 13½oz. I determined the amount of arsenic in all the viscera as ·011, one-ninetieth of a grain of arsenic, calculated as arsenious oxide. This amounts to ·0002 per cent.

2225. (*Dr. Whitelegge.*) Were the whole of the 13½oz. of the viscera taken for this examination?—Nearly the whole; it was calculated on the whole.

2226. (*Chairman.*) And you extracted all the arsenic from that 13½oz. of matter?—Practically the whole.

2227. What means did you take to measure the absolute amount of arsenious oxide?—It was precipitated eventually as a sulphide of arsenic.

2228. It is a very small part of a grain, ·011?—It is.

2229. Is it enough to measure?—It is a quantity which is quite appreciable.

2230. (*Dr. Whitelegge.*) And measurable gravimetrically?—Yes, and also the fact that it was arsenic was determined by the method of Fresenius and Babo, and then converted into the crystals of the oxide of arsenic. It is weighable portion.

2231. Can you give us any information as to the consumption of arsenicated beer by the patients in these cases?—This was the history furnished me by Dr. Buckley, who was a member of the expert committee. The illness commenced on the 25th September, the last date of taking the beer was the 21st November, and she died on the 27th November.

2232. (*Chairman.*) She had taken the beer during October after having been ill?—Presumably, as far as I know.

Quantity of beer consumed in fatal cases.

2233. She felt ill, but continued taking the beer during October?—Yes. And the average amount of beer taken was under one pint daily, according to her statement. I may add, however, that the statements of patients of this class with regard to the amount they take must be accepted with some reservation. A glass of beer with this class of patient more commonly means a pint at least. A glass of beer is half a pint, but when the person tells you she takes a glass of beer it probably means a couple at least. This woman was not a hospital patient.

2234. Her illness was treated in private practice?—She was attended by a Dr. Fergusson, who first visited her on the 21st November. That is the day she ceased to take beer. I suppose he knocked off the beer.

2235. Was it knocked off probably on his advice?—I do not know; but the fact is that she is stated to have taken no beer from the day the doctor visited her. This was at a period when the fact that arsenic was present in Manchester beers was already known in Manchester. Another case was that of Mrs. Thompson, who died 32 days after ceasing to drink beer.

2236. (*Dr. Whitelegge.*) Is the consumption known in that case?—The statement by Dr. Buckley was that the average amount of beer taken by her was a little over one pint daily.

2237. (*Chairman.*) You said that four of the women drank beer largely; you would not call a little over a pint daily "largely," would you?—No; I think a pint is not. I had a note of four of them; probably I should correct that, and say it was three who drank largely. Her viscera also yielded arsenic, but too small to weigh the amount.

2238. (*Dr. Whitelegge.*) Had you the same amount of material to work upon in that case?—No; it is rather singular that in the case of Booker I had less than in any other case. In the case of Thompson the viscera I had were 33½oz., part of the liver, kidney, and part of the spleen.

2239. May we take it that the proportion of arsenious oxide recovered in that case was less than 1-90th of a grain?—Yes, less than 1-90th in the whole 33½oz. Another case was that of Alice Riley, who was alleged to have died 14 days after ceasing to drink beer.

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2240. Can you give the amount of beer drunk? Is this one of the cases of large consumption?—Dr. Laing, who attended her, described her as a big, fat woman, over the average height, and from her appearance thought her addicted to drink. She admitted having drunk beer, and sometimes beer and whisky mixed. She never could be got to say how much she took. In that case the amount of arsenic was, as in the case of Thompson, unweighable.

2241. (*Chairman.*) With regard to this small amount of one-ninetieth of a grain in 13½oz., if there was a small quantity throughout a large part of the body, that would amount to one grain in 90lbs?—Yes.

2242. It might be a large quantity in the body, although there was only one-ninetieth of a grain in 13½oz.?—It would amount to about 1½ grains in the body, which is nearly a fatal dose. But my experience is, that it is not equally distributed throughout the body.

2243. A larger proportion would be found in the viscera and the brain, and in the muscles?—Yes.

2244. And in the blood?—The amount in the blood I cannot speak of, so long after the cessation of the taking of arsenic.

2245. In the case of Alice Riley and Margaret McCabe, what did you find?—Alice Riley died 14 days after ceasing to take beer. She is the one I have just mentioned. Margaret MacCabe died 52 days after ceasing to drink beer, and the amounts of arsenic were unweighable. She was a drinker, but what amounts of beer she took I do not know. There is this to be said with regard to her, that she had a cavity in the lung; she was no doubt consumptive.

2246. And that may possibly have been the cause of death, accelerated by the beer-drinking and arsenic?—It might have been. In the case of Margaret McCabe the body was very markedly pigmented all over. I can compare it to a Hindoo.

2247. Have you any doubt that was from arsenic?—From her history and other symptoms I have no doubt the pigmentation was due to arsenic.

Pigme

2248. (*Sir William Church.*) Still, pigmentation often does occur in tubercular cases too?—Yes, but still it is a very marked case, and from the whole of her history and symptoms and finding the arsenic in the body I had no doubt in arriving at the conclusion that her death was from arsenic, or it might have been consumption accelerated by arsenic. The other case was that of Mary Jane Dyer. She died 23 days after ceasing to take beer. There was no history of how much beer she took, but she had the history of a woman who was generally a drinker, and took both spirits and beer. At the post mortem examination an enormous liver, weighing over 100oz., and the appearance of the kidneys, all pointed to the fact that she was in a rather advanced state of alcoholism. But she had the history of arsenic, and the rashes, and the pigmentation of arsenic.

No ars detecte Viscer some f cases.

2249. (*Dr. Whitelegge.*) And neuritis?—She had the history of neuritis too. She was an enormously bloated woman, with rashes of an herpetic character, and pigmentation.

2250. Do you think her case was one of arsenical neuritis?—I think so, although I found no arsenic in her viscera after death.

2251. And you do not think that the absence of arsenic in the viscera after death negatives the diagnosis of arsenical poisoning?—No, I gave that evidence on the inquest on this woman, that I believed that she died from arsenical poisoning.

2252. (*Chairman.*) Probably at the time she ceased to drink beer there was much more arsenic in her viscera than there was 23 days later, when she died?—Undoubtedly that would be so.

2253. Every day would take some of it away?—I think so, yes. I must add with regard to these cases that Prof. Dixon Mann, of Owen's College, had duplicates of all this viscera, and he found arsenic in comparable amounts in all the cases, that is to say, he found an appreciable amount in Booker, and very minute quantities in the cases of the other women.

2254. (*Dr. Whitelegge.*) Not including Mary Jane Dyer?—In Mary Jane Dyer he found none also. The

analyses we conducted separately, but before the inquest we compared our results, and substantially they are the same.

2255. Is it usual to test the viscera for arsenic without any special reason for suspicion in the case of a post-mortem examination?—Yes; I frequently do it. In fact, I always do it for any viscera submitted to me by the Home Office or the Treasury.

2256. Without reason to suspect arsenic you would still test for it?—Yes.

2257. And the small traces you have found in those five cases were all more than you have found in other cases in which you have looked for it?—Yes. I have found it occasionally in small quantities in some portion of the viscera, the spleen for instance, but if I do not find it generally and only in exceedingly small proportions, I could not form the conclusion from analysis alone that arsenic had been in any way the cause of death, but the history pointed to that conclusion. In all cases of analysis of this kind the facts of the chemical analysis must be supported by the clinical observations on the patients, or the lesions found after death.

2258. And you would not be surprised to find some small traces of arsenic in an ordinary case?—I should only exceptionally find it. Occasionally I have, but not commonly.

2259. Is it a fact that the most rigorous analysis of viscera, or of spleen or liver of a healthy human body shows absolutely no trace of arsenic?—It is obvious I have never had an opportunity of examining the viscera of a healthy person, but in ordinary cases where there is a suspicion of poisoning, or in cases of patients in the wards of hospitals, and so on, one does find a very minute quantity exceptionally in some organ. For instance, last year I found it in the case of a patient who died in Guy's Hospital, in the spleen—I did not find it in the other organs.

2260. That was not a case of poisoning?—Not a case in which I could learn of any arsenic. The experiment was performed with the object of seeing whether arsenic was a normal constituent of the body or not. I found it in one organ and not in the others. Of course, I only examined a few of the organs.

2261. You have been struck with the lengthened periods during which arsenic remained in the body?—Yes. Ordinarily, if a person is taking arsenic, or has been poisoned by arsenic and is recovering, one tests the excretions, and the urine is the one in which one especially looks for it. If you give a patient one dose of arsenic, say, a 14th or 15th of a grain, you can detect arsenic in the urine within an hour or two at the utmost, and in such cases I have examined the urine day by day for many days after arsenic has ceased to be administered; it sometimes disappears, so far as one can recognise, in four or five days, more often in seven or ten days, or a fortnight, and I do not think I have ever discovered it in more than from 21 to 25 days after it has been ceased to be taken. Exceptionally, however, others have found it for extraordinarily long periods, I think, for 60 or 90 days.

2262. Has that been after a large quantity of arsenic had been administered?—No; after a small quantity, but I think some doubt attaches to the experiments. It was a Russian who did it not long ago, but the quantities of sulphuric acid and zinc, and other materials which he employed in getting out the arsenic, especially as he records no blank experiments, throw great doubt upon his experiments. I think one member of the Commission will appreciate it, that if you take 70 or 80 grammes of sulphuric acid, and get, say, 1-100th or less of a millegramme of arsenic, it is quite possible you may get it from the material you employ, the quantity of material employed being so huge in comparison with the amount of material, say, 6 or 10 grammes taken for analysis. Scherbatchoff made the experiments and recorded the experiments in April last year

2263. (*Chairman.*) Can you find arsenic excreted by the skin?—Yes. I have made no special experiments in that direction myself, but M. Armand Gautier and others have found it in the skin; and M. Gautier goes so far as to say that it is a normal constituent of the skin. I have been in constant communication with my friend Dr. Dixon Mann in Manchester, and he has made special researches in the skin in these cases, and he finds arsenic in the skin, the epidemic scales which peel off the skin in these arsenical cases.

2264. But not in healthy subjects?—I do not think he has made any experiments in those. You must understand that in these cases you can peel off huge flakes in weighable amounts. You cannot get enough of the skin of a living individual to test it. With regard to the pigmentation, I was struck on going round the Crumpsall Infirmary and examining the patients, who were very numerous, alleged to be suffering from arsenical poisoning—they were all beer drinkers; I asked them all that question—with the amount of pigmentation. It was the rule, and not the exception. Pigmentation you will not find described in the text books, except recent ones, as being a very marked symptom; but it has been observed. I do not know that I have ever seen it when neuritis has followed acute arsenical poisoning; I have seen several cases—I saw a girl in consultation in Somersetshire, only about six weeks ago, who was poisoned by arsenic. She was one of the survivors, a girl of eleven, of a family who were poisoned; she had marked neuritis, and could not walk, but I could discover no pigmentation in her skin. A lady I saw some time ago had had her life attempted by arsenic—she recovered and had neuritis very severely; she had no pigmentation as far as I could make out. Pigmentation common in Crumpsall Infirmary cases.

2265. (*Chairman.*) Was this just one poisonous dose?—This lady had had several $\frac{2}{3}$ grain doses, that is nearly a fatal dose.

2266. Taken by accident?—No, it was administered, I am afraid, with intent to poison.

2267. Was there an investigation?—No. The person who was alleged to have done it committed suicide, and nothing came of the case.

2268. Was the lady very ill afterwards?—She was very ill; so ill that the paralytic affection extended and invaded the lower muscles of respiration and the diaphragm, and great apprehensions were entertained for her life.

2269. Has she perfectly recovered?—Yes.

2270. Are there any evil results?—I lost sight of her eventually, but she was out of health for a long period. Pigmentation has been observed, and perhaps Sir Lauder Brunton will tell you about that. That was in what was termed the Hyères epidemic in the south of France, where from the plastering of vines by means of arsenic which was used instead of sulphate of lime, there was an extensive outbreak among the wine drinkers. Hyères epidemic

2271. Were there any deaths?—Yes; a good many deaths; I have not the details before me, but I think pigmentation was a marked feature in that epidemic. The quantity of arsenic in the wine I think was about 150 millegrammes in the litre in some cases. It is very difficult when you examine the liquor after the people have died to see what was the average amount, but I think Sir Lauder Brunton, who has the note of the facts before him, will tell you about the pigmentation in those cases.

2272. We have heard something of that already, and will hear more no doubt from Sir Lauder Brunton?—Yes.

2273. You mentioned acute arsenical poisoning only; is pigmentation common in chronic arsenical poisoning?—I do not think it is common. Pigmentation.

2274. But it is known?—It is known.

2275. (*Sir William Church.*) It is known, is it not, as a result of arsenic given medicinally over a long period?—Yes. A well-known professional gentleman told me lately that he had been given arsenic, and that he was warned against the symptoms by the doctor; but he was not told about pigmentation, and his attention was attracted by the amount of discoloration he got about the face and hair.

2276. That has been known for a long time, has it not?—Yes.

2277. (*Chairman.*) Does the pigmentation disappear when the patient recovers?—Yes, it disappears in time, but it is a very long affair.

2278. It remains a long time?—Yes, because these deposits of pigment in extravascular organs, in parts like the skin, take a long time before they disappear. There is apparently not much absorption.

2279. (*Professor Thorpe.*) Do you know anything about the nature of the pigment—what is the pigmenting material?—I do not know.

2280. Do you know whether it is arsenical itself?—I do not know.

2281. (*Dr. Whitelegge.*) How many cases did you see at Crumpsall, roughly?—I saw a great many, but I think

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I must have examined probably a dozen or 15 pretty closely. They all seemed to be repetitions of one another.

2282. And was pigmentation common amongst them?—Yes.

2283. Can you tell us the proportion of pigmented cases to the whole number?—No. I did not take any notes at the time, and I left Dr. Luff and others to follow that up.

Arsenic in bones.

2284. (*Chairman.*) As to the arsenic lingering in the bones for lengthened periods, what do you say about that?—That has been asserted and denied, and re-asserted, and I cannot give any positive information on it. Orfila stated that it had been found in the bones, but he is refuted by Dr. Owen Rees, and he admitted he was wrong, and then it was re-asserted that it has been found in bones as well as in other organs.

Gastro-intestinal symptoms in epidemic.

2285. (*Sir William Church.*) Arsenic, you say, has engaged your attention very frequently, clinically, pathologically, and analytically. The symptoms that usually indicate arsenic poisoning are generally connected with the stomach and the intestines, are they not?—Yes, very frequently. Administered medicinally, as you know, the eyes and nose are often the first portion to suffer. There is irritation of the mucous membrane generally.

2286. Did the information you got at Manchester lead you to come to the conclusion that gastric and catarrhal symptoms were absent in a great many of these cases?—Gastric symptoms certainly were; catarrhal symptoms were more common, but still they were not universal. In a great many of the patients I saw you could see the injected conjunctiva of the eye, the watery appearance, and so on.

2287. Did many of them complain of irritation?—Some did, and in some you could see the symptoms, although they did not describe it. But when you get the bleary, watery eye of the people who are habitual drinkers, any observation of that kind is liable to be fallacious.

2288. Still, the absence of gastric symptoms was calculated, was it not, to make the medical men in the district slow in recognising that it was likely to be arsenic?—Certainly. With regard to the pigmentation, there is no doubt that when attention was drawn to it many out-patients of the hospital were stripped, and then pigmentation was found where it was previously not suspected.

Arsenical and alcoholic neuritis.

2289. With regard to the neuritis, the palsy, did it appear to you to differ in any way from what you had been acquainted with under the name of alcoholic neuritis?—No, except that it was very pronounced. If you took the patients' bed-clothes off, or touched them, they said it was like electric shocks, pins and needles, and numbness. The increased sensibility was very marked, more so than in most cases, I think, of alcoholic neuritis.

2290. But was the general appearance of the patients, the look of their eyes, their hands and their feet, and even of their faces, almost indistinguishable from what we have called alcoholic neuritis?—Yes, I think so.

2291. What did you attribute the actual causes of death to in those fatal cases?—I arrived at the conclusion that it was arsenic.

2292. I rather meant in what way did it act fatally?—Of course, the only case I saw in a dying condition was one in the Crumpsall Infirmary, whose viscera I had no opportunity of analysing. She was dying, apparently, from paralysis of the diaphragm.

2293. You would not like to say whether the others died chiefly from that cause, or from exhaustion, or other causes?—I cannot say that.

2294. You have told us that the liver of Mary Jane Dyer weighed over 100oz., and looked like that of a person in advanced alcoholism. What was the condition of the other livers, were they equally large, fatty livers, or what we more often call cirrhotic livers?—I have only had a portion of the livers of each, but the half I took of Dyer weighed 53oz. The only other case I can state the weight of would be that of McCabe. In the case of McCabe I am afraid I cannot give you the absolute amount, but I had 13½oz., and Dr. Dixon Mann had 16½oz., which would make 30oz. on the whole. That is below the full amount, of course. I did not make the post mortems.

Effect of arsenic on liver.

2295. Perhaps I can get what I want to know in this way: What is the usual effect of chronic poisoning by arsenic on the liver?—In the eventual stage you get contraction, cirrhosis, but if you have extensive kidney disease and cardiac dilatation and so on, you may get an enormously large liver.

2296. Do you mean that chronic arsenic poisoning leads to cirrhosis?—No, I am speaking of alcohol.

2297. I was asking you about arsenic?—I do not know of any, except fatty degeneration. I have had to deal this year with an acute arsenical epidemic in a family. Five out of seven or eight people in one family died, and I think that in certainly two, and probably three, of those cases there was extensive fatty degeneration.

2298. Without great enlargement?—Yes.

2299. Therefore the enlargement that has been so commonly found, as we have had it in evidence before us in these cases, at Manchester and Liverpool, point to the probability of their being alcoholic as well?—Yes. I came to the conclusion from Dyer's viscera that she was an alcoholic. With regard to arsenic, fatty degeneration, in an extensive form at all events, is the exception rather than the rule. But you do observe it from time to time.

2300. Does chronic arsenic poisoning have any effect upon the heart muscle?—I cannot speak of my own observation, but it is said to cause fatty degeneration of it.

2301. You know that the medical officers attending these cases have found that dilatation of the heart has been very frequent in the fatal cases?—Yes.

2302. Would you associate that probably with the action of arsenic upon the heart?—I think so. The cases I saw in the hospital were, I should say, obviously cases of dilatation.

2303. (*Dr. Whitelegge.*) Do you regard alcoholism as predisposing to arsenical poisoning?—I have no opinion on that point. I have not had an opportunity, previous to this epidemic, of observing it.

2304. (*Sir William Church.*) Have you formed any opinion as to whether it is possible that arsenic, when introduced into such substances as beer in the process of manufacture, can enter into a chemical combination which we are not well acquainted with, and may have a more prejudicial effect upon health than ordinary arsenious oxide?—Do you mean in the beer itself?

2305. Yes?—I know of no evidence of that. Of course there are what are called the cacodylic compounds—we take those for example, and generally those are less potent than arsenic in the arsenious or arsenic form, the mineral form, if I may use the term. But the examination of the beers leads me to the conclusion that it is probably altogether, or practically altogether, in the form of an arsenite. When you treat organic combinations, or even viscera containing small quantities of arsenic, by the Reinsch test, boiling with copper and hydrochloric acid, you may get a slow deposit of arsenic on the copper, but with respect to the beers it comes down quickly and readily in the form of arsenic. I do not go so far as Professor Delépine, who told me that you can detect arsenic in beer by Reinsch's test much more readily than in water. At all events you can detect it as readily, I think. There is no evidence whatever, so far as I know, from the chemical examination, to show that there is arsenic in an organic combination.

2306. That hypothesis has been already put to us?—I have heard of that, and I have discussed the matter with people, and it has been said by some of them to account for what I may call the anomalous symptoms observed in these cases of beer drinking; but there is no positive evidence in support of it, as far as I know.

(*Chairman.*) It has been asserted that arsenic is a normal constituent of the human body?—It has been asserted, and it has been denied again and again.

2307. In the thymus and thyroid glands?—Armand Gautier asserted within the last two years he found it in the thymus, the thyroid, in the skin, and did not find it in the blood or the uterus, but found it in the fœtus and the bone of the fœtus in the uterus, and found it even in cow's milk, in operating on three litres. I cannot from my own analysis and examination of the experience of others arrive at the conclusion that when found it is anything but adventitious; it is not normal. It is very difficult to say, when you examine a portion of the body analytically, that the person has never taken arsenic. We know that arsenic does exceptionally linger in the body for lengthened periods, and I know from my own experiments and from the experiments of others that the sources of arsenic in the human body are very numerous. I do not mean to say arsenic in an important amount, but arsenic in excessively minute amounts.

2308. (*Professor Thorpe.*) Is there anything *à priori* absurd in the supposition that arsenic would tend to accumulate in the bone? The close affinity of arsenic acid to phosphoric acid, the fact that they are so constantly associated in nature, that they mutually replace one another in nature—a large number of minerals, for example, crystallising in the same form—would you not *à priori* expect that arsenic acid may be found in union with lime in the bone?—There is nothing improbable in that. In fact, M. Gautier asserts that it is in those portions of the body which contain phosphorus that you find arsenic. He says arsenic replaces phosphorus in what he terms the nucleins. It is possible in bones, but I have examined a number of bones, and as a rule I found none in the bones. In the bones of persons who have been poisoned by arsenic that I have examined I have found none, and I think as a rule one does not find notable amounts of arsenic there more than in other portions of the body.

2309. But arsenic is sometimes found in the ashes of wheat, for example, replacing apparently the isomorphous phosphoric acid?—That is the supposition, that it replaces phosphoric acid normally. Wheat is often grown on arsenical soils, and arsenical manures are in constant use for manuring the soil.

2310. (*Chairman.*) Is not that a danger?—There is a danger of the introduction of small amounts into the body.

2311. And is there not a danger of introducing it into the food?—Yes.

2312. (*Sir William Hart-Dyke.*) Are you referring to artificial manures only, or would you include what is called the common farmyard manure?—The superphosphates, the artificial manure—that is to say, the superphosphates made with pyritic sulphuric acid.

2313. (*Professor Thorpe.*) Do you imagine that all the arsenic found in these manures comes from the use of the oil of vitriol, and is not pre-existent in the bone phosphates converted into superphosphates?—There may be some, but of course the use of mineral phosphates containing arsenic may introduce some of it. Probably the sulphuric acid is the main factor. In the manufacture, not only of superphosphates, but of sulphate of ammonia in gas works, you get sulphide of arsenic separating sometimes as a yellow substance in the neutralisation of the gas liquors.

2314. Arsenic acid is not so poisonous as arsenious acid, is it?—It is generally believed to be slightly less so, but I think the opinion of the medical practitioners, if you may judge from the pharmacopœa and the quantities prescribed, is that the amount of arsenic prescribed as arsenate is pretty much the same, rather less in fact, than the amount prescribed as the arsenious compound.

2315. Have any exact observations been made as to the relative toxic effect?—None very exact, I am afraid.

2316. Would they be complicated by the fact that the arsenate might be reduced to arsenious oxide?—It might, and a greater liability of the arsenates to form insoluble compounds. Insoluble compounds are much less poisonous than soluble compounds.

2317. (*Chairman.*) May insoluble compounds not remain in the body and become decomposed into soluble compounds?—Yes; even the arsenate of calcium, the arsenate of lime, is, like most other bodies, to some extent soluble, although very little. It may pass into solution again, but still it can only pass slowly into solution when once formed.

2318. (*Professor Thorpe.*) The hydrochloric acid of the gastric juice would dissolve the arsenate, would it not?—Yes, if introduced into the stomach; but I am speaking rather of the other portions of the body remote from the stomach. Almost any poison when introduced into the gastric juice would quickly pass into the circulation.

2319. For example, supposing that arsenate of lime was present replacing phosphate of lime, or alumina in wheat, that would do its work as a poison by the action of the hydrochloric acid of the gastric juice?—Yes.

2320. (*Chairman.*) I suppose we may take it that an absolutely insoluble substance could not be a poison, and that it is only when very sparingly soluble substances, or substances insoluble in water, meet with solvents in the body that they become poisonous?—Sulphate of barium is a signal instance. All the barium except the sulphate are poisonous. It is even asserted that the yellow sulphide of arsenic, which is practically insoluble, is non-poisonous.

2321. Is yellow sulphide of arsenic not attacked by any liquors that it meets in the human body?—It would be attacked by alkaline liquids; but in the acid liquors it is practically insoluble. *Dr. T. Stevenson.* 13 Mar. 1901.

2322. And it would not meet alkaline liquids in a healthy body?—When it passes beyond the stomach it would, but they would be so very faintly alkaline that it is very doubtful whether much solvent action would be exerted. Many articles of food may contain arsenic. I have already mentioned those that are grown, vegetables grown on arsenical soils, and arsenic in the soil is by no means a rare occurrence. The use of manures in the preparation of which arsenical sulphuric acid is used increases the chances of a mixture of arsenic with vegetables. Then the use of weed killers, strong compounds of arsenic used in gardens, may introduce arsenic into our food. This is not my own observation, but it has been said to be found in cruciferous plants, such as turnips and cabbages, and even in the potato. I may state that the superphosphates are largely used for the growing of turnips. Many chalybeate waters are arsenical; the Vichy and others, I think, contain arsenic, and the ferruginous deposits from waters that are good for drinking purposes often contain arsenic, even when the water is practically arsenic free. The ferruginous deposits you see about drain pipes, if examined, are found to contain arsenic, and if you examine water in the ordinary way you may find no arsenic; that is to say, the arsenic is present probably in very minute amounts, so that they escape detection except a large volume of water is employed. Rivers from which drinking water is obtained may contain arsenic, which is frequently cast into the rivers from tanneries, for instance. Articles of food containing arsenic.

2323. Do you know of any recorded facts with reference to arsenic found in turnips and cabbages?—I cannot give the reference, but Gauthier, in his paper, which appeared in the *Comptes Rendus* about two years ago, mentioned the fact that it has been observed there. Manured vegetables.

2324. Does he state facts in detail?—I do not think he does.

2325. Is he a French writer?—Yes.

2326. Is he a medical man?—He is a medical writer and a chemist of some distinction.

2327. You say that many chalybeate waters are arsenical, and that rivers from which drinking water is obtained may contain arsenic? Have you any statement as to the quantities of arsenic in such cases?—No; it must be small. I have examined the liquors from tanneries, and the substances they use, and they are arsenical. They are thrown into the river.

2328. That arsenic in the river, you mean, comes from preparations used by tanners?—Yes, what are termed depilatories, substances used to deprive the pelt of the hair.

2329. What substances are they?—Formerly they were chiefly a mixture of yellow sulphide with lime, but those are largely superseded by substances which are sold under fancy names, which the tanners do not always know contain arsenic; but they are really compounds of arsenic with an alkali, such as soda and lime. Arsenic in hides.

2330. (*Dr. Whitelegge.*) And are not hides imported into this country which are arsenicated with the idea of curing or preserving them?—I believe so.

2331. (*Chairman.*) Arsenic is also used, is it not, to preserve natural history specimens, the skins of birds and beasts, and so on?—That is so sometimes, but it is found that in sheepskins if you immerse the sheepskins in a mixture of lime and water you can pluck the wool off easily. It acts as a depilatory. But in the imported skins of French lambs, and the Australian skins, they find that by using a compound of lime and arsenic, or lime and soda, instead of lime alone, the wool may be brought off in a fraction of the time which is required when lime alone is used.

2332. Will lime and soda answer as well as lime and arsenic?—They do answer, but they are longer about it.

2333. So that they prefer arsenic?—They use arsenic freely.

2334. Is not that dangerous to the health of the persons employed in a tannery?—Yes.

2335. Are there cases of arsenical poisoning in tanneries?—I have met with them, serious ones too. But when one has pointed out to the masters the danger they take precautions. I have seen numbers of men in tanneries who were affected, that is to say, they got their

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cheeks affected, and their eyes, their lips, and their genitals, from handling them with unclean hands, when urinating, and they get troublesome sores. But of late years I have met with no such cases, because I think the masters are well aware of the risk they run.

2336. (*Dr. Whitelegge.*) Are these symptoms entirely external, or have you met with cases where they have been internal, or constitutional?—No, not constitutional symptoms.

Arsenic poisoning in tanners.

2337. (*Professor Thorpe.*) Have you met with any palsy?—No. They get the particles of this stuff on their fingers, and carry them to various parts of the body, and thus set up local irritation, generally irritating sores. I saw a man once who had his cheek perforated with such a sore.

2337*. (*Chairman.*) Was he a tanner?—Yes.

2338. Is there not a danger from leather gloves prepared in that way, a danger to the wearer by reason of the arsenic contained in the leather?—I think in regard to skins that they mostly use mercury compounds, and there there is a danger to the workpeople also, as I recently pointed out to the Home Office. I have seen several cases in people making felt hats, cases due to mercury.

2339. But with regard to leather, prepared by the use of arsenic in a tannery, is not that dangerous when used in the ordinary articles, trunks, portmanteaux, and skins in houses? Does not that raise the same kind of danger as arsenical wall-papers?—I cannot instance any causes where evil results have followed, except to the workers, from such materials.

2340. (*Professor Thorpe.*) Has the German Government taken any action in their general sanitary law about these things prepared with arsenical compounds?—I do not know. Probably if anyone did the Germans would, but I cannot specify, as I am not acquainted with the German law.

Liability of apples to contain arsenic.

2341. (*Chairman.*) Have you any quantitative results as to the amount of arsenic found in ferruginious deposits from waters?—No, I have not. Again, we have the application of arsenical compounds to such things as apples. In America they syringe the apples and the apple trees with arsenical compounds, and the vines, to destroy the blight. These, of course, are a source of conveying arsenic into the system. Arsenic may thus get into preserved apples, in apple chips which have been imported.

2342. In poisonous quantity?—In small quantities. It is difficult to say what is a poisonous quantity.

2343. Have you heard of arsenical illness traceable to such causes?—Not in this country.

2344. Have you heard of arsenic in tinned fruits or tinned vegetables?—No; those do not generally contain arsenic, but they contain lead and zinc sometimes. I have not met with arsenic in those myself.

2345. (*Sir William Church.*) In the case of imported apple chips and apples containing arsenic, do you think that arsenic was contained actually in the apple, or was it accidental contamination at the time the chips were dried?—They use arsenical compounds for syringing apples.

2346. That is, they syringe the growing apples?—Yes.

2347. I should have thought it was more likely that arsenic found in the apples themselves and the apple chips came from some accidental contamination during the process of manufacture or drying. Do you think the arsenic got in in the peeling of the apples from the arsenic remaining on the peel all the time?—I think it is quite possible, and far more likely than to occur in the process of drying the apples.

2348. It is the same thing. The arsenic was not inside the apples?—No.

2349. Then it has been an accidental contamination of the apple pulp?—From the skin?

2350. Either from the skin or something else?—Yes.

2351. (*Chairman.*) If arsenic has been used in the skin, could not small portions be absorbed into the apple in moistening it and dissolving some of it?—It is possible, I think, but not very probable.

2352. I believe you have something to say about the use of arsenic for sheep dips?—Sheep dips are commonly arsenical, and I suppose some of it is very likely to be absorbed into the body of the sheep, just as we know that if arsenic is applied to the skin of animals and human beings it is absorbed.

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Arsenic fattenin poultry.

2353-5. I am told that it has been stated in a recent number of the "Daily Mail" that arsenic is used in the food for fattening poultry?—I do not know anything about that. It is said that the Strasburg geese were fattened by means of antimony.

2356. It was stated that for the ordinary fattening of poultry food containing arsenic was used to facilitate the fattening?—It is impossible for me to deny it, but I have never heard of it. We have arsenic, of course, given off during the burning of coal and coke, and soot is decidedly arsenical; I think it has been stated to contain as much as 1 per 1,000 of arsenic, and the soot-laden air of our cities does certainly contain occasionally detectable quantities of arsenic. Smoked articles of food are exposed to arsenic. It has been found in hams which have been dried by means of coke fires. I suppose, as gas coke is commonly used in London, the chops and steaks, and grills generally cannot fail to contain some arsenic.

in smok hams,

2357. Our only safety then would be the use of electric grills?—I do not say it is unsafe. I am merely pointing out the innumerable sources of quite inconsiderable amounts of arsenic in our food supplies. There is a method of preserving food by the use of borates which introduce arsenic into the food. I have this year examined a large number of samples of borax and some samples of boric acid, and I have not found one absolutely free from arsenic, although in one case I had some specially prepared for me with carbonate of soda. It is small, but still there are traces of arsenic.

in boric

2358. (*Dr. Whitelegge.*) What is the maximum you found in borax?—The maximum I found was ·35 of a grain, calculated as arsenious oxide, per pound of borax.

in borax

2359. (*Chairman.*) That would be about 1 part in 20,000?—Yes, about that. That was a sample which I believed was analysed by a Glasgow chemist also, who found ·4, practically the same amount.

2360. Have you always found arsenic in borax?—Yes, but that is the largest amount. It usually contains about 1-10th of that amount.

2361. (*Professor Thorpe.*) Does that come from the oil of vitriol used or from the natural deposits from which the borax is made?—I think from the natural deposits. The manufacturers tell me that borate of lime, which is used in the preparation of these things, often contains a good deal of arsenic.

2362. (*Chairman.*) Borax is largely used for the preservation of milk, is it not?—Yes; and cream, fish—fresh, salted, and dried—game; and the poulterers largely use the borates in summer weather. A mixture of boric acid and borate of sodium is commonly used for dusting over game, fish, and those kind of things which are liable to decomposition.

2362A. And the quantity of arsenic in it would be a source of danger, do you think?—I do not think it is a source of danger, but is a source of arsenic.

2363. May the quantity be larger in milk?—One part of borate in 1,000 or 2,000 of milk is a common quantity.

(*Dr. Whitelegge.*) Is boric acid made from borax?—Borax is made from boric acid; that is to say, the borates of lime or calcium are used and the boric acid is separated. I believe a great deal of borax is made from the boric acid, but I have never seen it made.

2364. Is sulphuric acid used in the manufacture of boric acid or borax?—Yes; sulphuric acid, or hydrochloric acid, or both, but the natural material is borates, which frequently contains minute quantities of arsenic—at least, so the manufacturers who make these things tell me.

2365. Have you found arsenic in boric acid as well as borax?—Yes. I mention these sources of the introduction of arsenic into the body, not that I think significant quantities are thereby introduced into the body, but to point out that some allowance must be made and some agreement come to as to the quantity of arsenic which is permissible, if any is permissible at all, in articles of food, drink, and drugs. The term "arsenic free" must have some reasonably analytical interpretation put upon it.

2366. (*Chairman.*) I think you scarcely mean to say "permissible," but rather avoidable?—That would be a better word. There are many points which I have not

cleaned up yet; and perhaps some opportunity may be given to me on a future occasion to bring them before the Commission.

2367. We shall be very glad to hear anything you can give us, either now or at some other time?—I am engaged with my fellow-experts in making investigations as to the sources of arsenic in beer, and the means by which they might be avoided—coke, coal, acids, malts, hops, and so on, and our experiments are not yet completed.

2368. As a rule, can arsenic be easily removed from the chemical known to contain it; for instance, from boric acid or borax?—No.

2369. I am told that it is quite easy to remove it from sulphuric acid?—Yes. I have seen practically the whole of it removed.

2370. But not from boric acid?—No.

2371. (*Dr. Whitelegge.*) How does the difficulty arise in the case of boric acid?—If you re-crystallise it again and again some of the arsenic will still attach itself to the boric acid or the borate. When you get two substances together in the form of crystals it is often very difficult to entirely separate one from the other by re-crystalisation.

2372. (*Chairman.*) Can the arsenic not be precipitated by sulphuretted hydrogen or otherwise from a solution of the substance?—In the quantities present I do not think it is practicable. For instance, in the samples of borax I have examined when you dissolve the borax and acidify it to keep the boric acid in solution you have such a dilute solution that the arsenic cannot be precipitated by sulphuretted hydrogen; whereas if you distill the boric acid or the borax with hydrochloric acid, you get the distillate, but the difficulty of separating it commercially, to remove the least trace, is enormous, and I believe I may say quite unnecessary and no source of danger to the public.

2373. (*Chairman.*) Is it practically innocuous?—Yes.

2374. (*Professor Thorpe.*) In that particular case I quite agree that the amount is negligible, but if it were a matter of importance to free it even from boric acid or borax, I do not think there would be any difficulty in doing it?—I do not think the difficulty would be insuperable, but it would be a very troublesome and costly process. I think the chemist, if he makes up his mind to separate any ingredient, can generally manage to do it in the end.

2375. Take the case of the boracic acid. That perhaps would be remarkably easy, because the curious point about boracic acid is that, although pretty soluble in hot water, it is not so in cold water, so that if one were to take borax or borate of lime containing arsenic, and one were to treat it, as one does in the process of manufacture, with hydrochloric acid, the greater quantity of the arsenic would remain in the mother liquor and the boracic acid would be thrown out?—Yes.

2376. That would leave it practically, or very nearly, free, and a repetition of that process would practically get down the arsenic to a negligible quantity, would it not?—Yes, in the greater proportions of boric or boracic acid I have examined the quantity is very small; it does not amount to more than 1-20, 1-30, or 1-100 of a grain per lb. It is negligible as regards health purposes.

2377. But if I might be allowed to pursue that, of course you would draw a sharp line of distinction between arsenic introduced into products which may enter into the compounds of food and sulphuric acid, and the arsenic introduced into products where the arsenic, so to speak, is of a natural origin. Now, I presume it would not be difficult to exclude arsenic introduced into foods by sulphuric acid incidentally?—No, it would not.

2378. It might be more difficult to exclude it in articles of food derived from natural products which themselves might contain arsenic?—Yes.

2379. But in so far as these natural products were derived from the use of arsenicated manures, which were themselves derived from oil of vitriol, it ought not to be difficult to exclude them?—No; prohibit the use of arsenical sulphuric acid in the preparation of manures and that source is removed.

2380. How many substances occur to you containing arsenic derived from what may be called a natural origin?—It is difficult to say; but the borates, the phosphates, phosphate of sodium, and so on.

2381. May I ask you about the phosphate of soda? We know that occasionally samples of phosphates of soda are found to be associated with arsenate of soda, but in that case how is the arsenic derived?—It may be from the sulphuric acid, or it may be possibly from the carbonate of soda.

2382. But even from the carbonate of soda, if it is in the carbonate of soda it has been derived from the sulphuric acid?—Yes, soda made from sulphuric acid.

2383. By the Leblanc process it would be obtained from the sulphuric acid?—Yes.

2384. If we exclude it from the sulphuric acid we can also exclude it from the soda?—Yes.

2385. What other source of arsenic could there be in phosphate of soda other than the sulphuric acid and the carbonate of soda?—I think practically none.

2386. In that way, therefore if it were required we could free the phosphate of soda from even the last traces, or almost the last traces, of arsenic acid?—Yes.

2387. I should like to gather from you what other articles of food other than those which are prepared by the intervention of oil of vitriol there are which could contain arsenic acid or arsenious compounds generally?—I think it is difficult to run over everything; but the other sources, I think, are negligible.

2388. Do you mean they are not at all a matter of serious moment?—I think not.

2389. So that if steps could be taken to exclude arsenic from the oil of vitriol practically we should abolish the greater portion of the danger?—Yes; you would not get it in the hydrochloric acid.

2390. Which is an incidental product, in the same way, of sulphuric acid?—Yes.

De-arsenicated pyritic acid may be as free from arsenic as brimstone acid.

2391. In fact, it is the arsenic from the pyrites which is practically the origin of the large portion of arsenic which is found in sulphuric acid and sulphuric acid derivatives?—Yes, and that need not involve the abolition of pyritic acid, because pyritic acid can be freed from arsenic and rendered quite as free as sulphuric acid made direct from brimstone.

2392. Are you conversant with the mode of manufacture of oil of vitriol on a large scale?—I have visited works. I do not advise any works, but I visit them from time to time. I spent a whole day last week in a vitriol works.

2393. Are you familiar with the technology?—Fairly well.

2394. The arsenious oxide in the oil of vitriol comes, of course, from the double sulphide and arsenide of iron present in the pyrites?—Yes.

2395. When the pyrites is roasted in the kiln the arsenious oxide is volatilised?—Yes.

2396. Is there any process known to you by which the greater portion of that arsenious oxide can be taken out before it gets into the vitriol chamber?—You are speaking of the ordinary processes?

2397. Yes?—Yes. A great deal of it may be taken out. In the Glover tower it is practically all taken out.

Synthetic sulphuric acid.

2398. Before it even gets to the Glover tower, is it not known to you that at all events the greater portion of the arsenious oxide may be removed?—Yes, a great deal is deposited in the flues, of course, and in the synthetic acid it is the essence of the process that all the arsenic should be taken out. You are acquainted, of course, with the process employed here and in Germany, that in the preparation of synthetic acid the sulphur is converted into tri-oxide, and that is dissolved in water, and the di-oxide being converted into the tri-oxide by passing it with air over finely divided platinum, if the di-oxide is not entirely deprived of arsenic before it passes over the platinum, the process is vitiated by the platinum becoming choked with the crystals of arsenious oxide. I have seen it done. The di-oxide is washed and washed until, when you look through perhaps 8 or 10ft. of the gas, with either an electric or bright burner, as long as the atmosphere above the wash water blurs the flame in the slightest it is not free from suspended particles of arsenic. In one works in the neighbourhood of London I suppose they make 500 or 600 tons of this synthetic acid every week, and of course they make other acid.

2399. (*Chairman.*) Is that from pyrites or from sulphur?—It is made from pyrites or from sulphur, but I think mostly from pyrites. But even in the old process of the chamber acid the greater part of the arsenic is got rid of before the acid reaches the chamber.

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2399* (*Professor Thorpe.*) You mean it ought to be?—Yes, it ought to be.

2400. That merely means, therefore, that if the vitriol maker would simply prolong the flue through which the gases pass on their way to the leaden chamber or to the Glover tower, he would greatly minimise the chances of any large quantity of arsenic getting into the acid?—Yes.

Construction of flues in sulphuric acid works.

2401. Are you aware of any place where this prolongation of the flue to get rid of the arsenic is practised?—No. I do not know where excessively long flues are used.

2402. Do you know that it is one mark of distinction between the Continental method of making oil of vitriol and the English method that on the Continent the sulphur di-oxide, before it enters into the leaden chamber or the Glover tower, is caused to pass through a flue atmospherically cooled, which leads to the deposition of the greater quantity of the arsenious oxide?—I have understood that is the case, but I have never seen any foreign manufactories.

2403. Do you know this book by Lunge on "Sulphuric Acid and Alkalies"?—Yes.

2404. Are you familiar with it?—I cannot say I am familiar with all the pages of it, but I know a good deal of it. The technology I am not an expert in except generally in the way I have indicated.

2405. In the manufacture of oil of vitriol, for example, in Saxony, where an extremely arsenical pyrites has to be employed, the sulphur di-oxide, on its way to the chamber passes through a flue, and the degree of condensation of the arsenious oxide is so great that upwards of 94 per cent. of the total amount of arsenious oxide present is condensed?—I was not aware of the exact facts, but I knew it was done. A very large proportion is taken out in that way.

2406. Why do you suppose an English maker delivers his gas straight into his vitriol chamber or into the Glover tower without this intermediate cooling through the flue?—I suppose it is cheaper probably.

2407. Why is it cheaper?—A long flue and cooling process must, I suppose, cost more than a short flue.

2408. What he seeks to get is the economy of the heat in the hot gases he is using?—Yes, of course the heated gases may be used as in the Glover tower for concentrating his acid. He does not want to lose his heat.

2409. The point I want to come to is this: Speaking generally, supposing some pressure were brought to bear upon oil of vitriol makers who use or make pyrites acid to cool their gas, we should have very much less arsenic entering into manures and all sorts of other products than now obtains?—Yes.

Individual susceptibility to arsenic,

2410. Have you anything to tell us with regard to the susceptibility of individuals?—I should like to say with regard to the susceptibility of individuals to arsenic, that it varies greatly.

2411. (*Sir William Hart-Dyke.*) Between the sexes or individual members of either sex?—Individual members of either sex. By far the larger number, I think, can bear 8 minim doses of liquor arsenicalis three times a day—that is the ordinary form in which it is given medicinally—for several weeks, without the supervention of toxic symptoms, that is, a dose of ·22 grains of arsenious oxide per diem. A few people can tolerate only a fraction of that amount. Exceptional persons are met with in whom a fraction of the amount produces distressing symptoms, and it has to be suspended. They get irritation of the eyes, rashes and so on. But this idiosyncrasy is observed with regard to many other drugs, chloral hydrate—for instance, a couple of grains, that is, a 10th part of an ordinary dose, may produce symptoms—opium, mercury, potassium iodide, and so on. And even we observe the same idiosyncrasy or susceptibility with regard to articles of food, such as onions, ginger—I know a person in whom ginger produces distressing symptoms—bananas, shell-fish, pork, and honey. In laying down restrictions as to arsenic in food, if such should be laid down, the idiosyncrasy of persons with respect to it cannot be fully met.

cannot be fully met.

2412. (*Dr. Whitelegge.*) Do you mean that it is commercially impracticable to meet it, or that it is not important to meet it?—I think you cannot.

2413. Let us take the case of beer. Do you think that the presence of some kind of arsenic is practically inevitable?—Yes. Occasionally you will find it. I am not speaking of important amounts of arsenic, but when you come to find, as we do, that there is a quantity which we estimate, say, at the 200th or a grain, or less than that, I do not think such quantities are important, and I think occasionally you will meet with this in beer prepared with great care.

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2414. Do you think that great care ought to be exercised to keep out arsenic as completely as possible?—Certainly.

2415. I anticipated your answer, but from your *précis*, I see you are about to give us 1-20th of a grain as a safe quantity. You would not consider it was immaterial whether the arsenic approached 1-20th or whether it did not?—I think it is important to keep out all you can, but I think that the great majority of persons, if they took 1-20th of a grain per diem, would not suffer. But some would, perhaps.

Exclusi minute ities o senic fr food—i practic bility

2416. (*Chairman.*) Should not there be protection for the more than ordinarily susceptible people? A large number of people would be injured by 1-20th of a grain of arsenic per day, would they not?—Yes. But what I mean is that there are some people so susceptible to such minute quantities that I do not think you can entirely protect them. I think that with regard to beer and all other articles of food, the provision as to freedom from arsenic should be carried to the utmost limit.

2417. (*Dr. Whitelegge.*) But you think that no grave public danger would arise from any trace of arsenic being present? I understood you to say that in the case of beer, and presumably other foods, every practicable precautions should be taken to keep out arsenic as completely as possible?—Certainly.

2418. But do you suggest with regard to beer, that as long as the accidental quantity present does not amount to more than 1-20th of a grain, no great public danger would arise?—If a person does not take more than 1-20th of a grain per diem, I think you would have very few cases.

Alcoh neurit fore t epide relati arseni

2419. But there would be some even then?—Probably there would be some, because it is quite likely that some of the cases of alcoholic neuritis which we have observed during the last few years may be due to beer containing small quantities of arsenic. My own experience teaches me that it is quite common in some districts of England to find arsenic even in modern hop beers, beer prepared with ordinary care, and the presumption is that these beers have been drunk for some considerable time, probably for years, without it being suspected that they were arsenical.

2420. Do you mean that there have been many cases of peripheral neuritis due to such beers?—There have been cases, but in proportion to the population very few, and nearly invariably in persons addicted to taking large quantities of beer.

2421. (*Sir William Church.*) One witness suggested to us that what we have hitherto called alcoholic neuritis is always due to arsenic. Would you go as far as that?—No; I do not agree. I discussed that matter with Dr. Reynolds—I presume you refer to him—and I think it is an unproved hypothesis. That beer drinkers are more prone to neuritis than spirit drinkers I think would be endorsed by the medical profession generally.

2422. Now?—Yes; and would have been before this epidemic, I think.

2423. Were not the original cases of alcoholic neuritis rather in mixed drinkers than in beer drinkers?—Yes; we used to suppose that.

2424. I think Sir Samuel Wilks' original cases were supposed to be spirit drinkers?—Yes; and now we have come round to beer drinkers.

2425. I suppose most of the spirit drinkers drink beer too?—Yes; I have examined, since this epidemic, in a hospital I am attached to—Guy's Hospital—several cases of alcoholic neuritis. There have been very few, and I have at least tried to see every case There were only three or four, and there was nothing whatever to indicate to me that it was arsenical neuritis. They had no pigmentation, none of the appearances of the eyes, none of the rashes, in fact, nothing to suggest that it was arsenical. I am not much of a clinical physician now-a-days, but so far as I know, there is such a thing as alcoholic neuritis and such a thing as arsenical neuritis. In fact, we have neuritis from other forms of metallic poisoning than arsenic, lead, for instance.

2426. But still, granting there is such a thing as

alcoholic neuritis, arsenical neuritis simulates it much more closely than does lead?—Yes.

2427. And more closely than diphtheritic paralysis?—Yes; because there are other symptoms which guide you to a diagnosis.

2428. (*Chairman.*) What do you say as to the cumulative action of arsenic?—The term cumulative or accumulative can be only, I think, a relative term. All poisons are in a sense cumulative. Even rapidly excreted alkaloids, such as strychnine, show a cumulative action when small safe doses are given at too brief intervals—that is, before the major portion of the previous dose has been excreted. I have seen many cases of strychnine given in small doses, and when a patient has taken a certain number of doses the strychnine spasm comes on, no doubt due to the cumulative action of the strychnine. I believe that arsenic is no more cumulative than many other poisons which are rapidly excreted. There are poisons, of course, which are only slowly excreted, and distinctly cumulative poisons, lead for instance. The patient may take a fraction of a grain of lead per diem in an article of food or drink, and dies eventually from lead poisoning, and you will find several grains of lead in his body, in his liver especially, the accumulation of many days. I know of no observation of a similar character with regard to arsenic. Even in the acute cases I have only once found more than half a grain in the liver. More commonly after a death from acute arsenical poisoning you will find a half or three quarters of a grain. When arsenic is given in repeated small doses, either tolerance is established, as in the rare cases of the arsenic eaters, almost unknown in this country; or what I may term the input or the output of the drug are balanced before a fatal dose accumulates in the body. That is probably what occurs in the majority of cases where arsenic is given medicinally without producing toxic results. Or again, the toxic amount is reached in the body before the point at which input and output are balanced. I may illustrate it in this way: If the daily dose be 0·22 of a grain, and we assume that one-fifth of the absorbed amount—I am not speaking of that remaining in the intestinal tract, but the absorbed arsenic is excreted daily—when there is 0·9 of a grain in the body the input and the output would be balanced; that is to say, 9-10ths of a grain would be in the body on a certain morning, and to give a patient the ordinary dose, ·22 would bring it up to 1·12. He excretes 1-5th of that amount during the day, and you will observe that the input and the output become balanced. He takes about a fortnight to arrive at that.

2429. (*Dr. Whitelegge.*) That hinges on the assumption of the 1-5th elimination?—Yes.

2430. Is that based on any data, or is it merely an illustration?—Merely an illustration. If you take it, on the other hand, that 1-10th only is excreted, the same condition will be arrived at in about three weeks, but the body will then contain about 2 grains, which is a fatal dose. Certainly, from the observation of the amount of arsenic excreted in the urine, I do not think that the excretion would give less than 1-10th of the amount taken.

2431. Of the amount present in the body?—Yes.

2432. The amount taken would be different?—Yes.

2433. In whatever combination or locality?—Yes, it is excreted very rapidly at first, at least in relatively large amounts, and then it gradually tails off.

2434. You gave us some instances in which it was found two months after ceasing to take the arsenicated beer, did you not?—Yes; in that case there must have been some small portion retained. Others have found it often after longer periods in very minute quantities.

2435. Why do you adopt 1-5th and 1-10th as illustrations? I presume you regard them as approximately correct?—Partly for this reason, if you give arsenic to a person you cease to detect it in the urine generally within a fortnight or three weeks. The quantity after that period is in any case almost infinitesimal.

2436. And in the tissues of a person you would not be able to take that amount into account?—No; but when you take it into account 14 days after death it is very small. 1-70th of a grain, I think, has been found 14 days after taking arsenic. If you cease giving arsenic on my assumption of 1-5th or 1-10th it disappears from the body in the same time that it took to raise it to that point. That is mathematically correct, I believe.

2437. Is that so? If 1-5th or 1-10th of the residual store in the body disappears in the course of each day, it would gradually reduce the amount of arsenic eliminated every day, and it might take an indefinite time to reduce the amount?—It would theoretically take an infinite time, but it would be practically reduced to zero in the same time that it took to raise it to the amount.

2438. (*Sir William Church.*) That is to say, as recoverable in the excretions and the urine?—I am speaking theoretically.

2439. (*Dr. Whitelegge.*) If it takes an infinite time, as I thought we agreed, to eliminate by that process of 1-5th of the residual store being removed daily, and taking also your other proposition that it takes the same time to eliminate that it takes to enter into the system, would not that mean that you must be taking the dose of arsenic for an indefinite period?—Yes, it would theoretically, of course. But may I just illustrate it in this way. Suppose you give a daily dose of ·22 of a grain, I have been calculating out the amount which would be present at the end of each day, the amount added on each day, and the amount excreted each day. The amount reaches in 21 days 1·96 grains, that is theoretically the total amount which would be present. Then I suppose that that arsenic ceases to be given, and in 21 days it is reduced to ·02 of a grain in the whole body.

2440. Is that on the basis of a constant daily elimination of equal amount?—No, a constant fraction of the amount in the body. It is obvious that if you give a certain amount, and say 1-10th of a grain is excreted per diem, you very quickly get the whole of the arsenic out of the body.

2441. But your suggestion is that the quantity is not 1-10th, or any other fixed amount, per diem, but always amounted to 1-5th or 1-10th of the remaining arsenic; 1-10th or 1-5th of the whole amount in the body?—Yes. I am assuming that when you give the arsenic, 1-5th or 1-10th of the whole amount in the body goes out per diem, and in the 14 or 21 days, according to the excretion, or the fraction of excretion, you get the amount in the body constant; and then I assume that you cut off the arsenic altogether, and in a corresponding period practically the whole of the arsenic disappears.

2442. (*Chairman.*) If it disappears at the rate of 1-5th of the quantity given out per day, it would be very quickly all gone?—Yes.

2443. 1-5th is 20 per cent. It is the compound interest principle. In eight or ten days there would be quite an imperceptible quantity left?—Yes, theoretically. It would practically all disappear in 14 days.

2444. (*Dr. Whitelegge.*) I am afraid I do not follow, but perhaps I shall see it more clearly in the print of your evidence?—If it is not clear, I should be happy to explain it.

2445. Assuming that 1-10th disappears in a day, you tell us that at the end of a very few weeks it would be reduced to a very small quantity, which I should not have anticipated as I understand the matter.

2446. (*Chairman.*) It is just the principle of compound interest. If a person loses his property at the rate of 5 per cent. per annum, you can easily tell how much he will have after twenty years?—Assuming that you have arrived at a stage at which the body contains ·88 of a grain of arsenic, and you give no more, in a week it will be reduced from ·88 to ·18 and in another week it would have practically disappeared.

2447. It depends on the hypothesis of the quantity disappearing bearing a fixed proportion to the quantity that is in?—Yes.

Elimination of a single large dose.

2448. Your calculation is perfectly correct there, but whether the assumption on which you found it is true or not must be a matter of observation or guessing as to what is probable?—Yes; I brought forward that illustration, because if you give arsenic to a person, say one dose, you will find a considerable quantity the first day and it rapidly diminishes day by day, until in from seven to twenty-one days it all disappears. If it were not rapidly excreted the amount which would accumulate in the body would very quickly far exceed a lethal dose.

2449. Do you reckon a lethal dose the total quantity that may be in the body at any time?—I mean the quantity which has actually destroyed the life of a human being.

2450. 2 grains of arsenic in one dose would destroy the life?—Yes.

2451. Does it follow from that that there might be 2 grains of arsenic in the body, and yet that it might be quite innocuous?—We know that there are arsenic

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esters—we do not meet them in this country; I have only met one—and the ordinary medical experience shows that if you give considerable quantities day by day exceeding the ordinary dose, you very quickly arrive at a time at which the patient shows signs of being poisoned by it.

Individual susceptibility to arsenic.

2452. (*Sir William Church.*) Do you know the largest dose anyone has taken with impunity for any length of time?—I have heard of 30-minim doses being given, which is heroic treatment.

2353. How many times in the 24 hours?—Two or three times.

2454. (*Chairman.*) Of Fowler's solution?—Yes; 30 minims at once; over a quarter of a grain.

2455. That would be a quarter of a grain a day?—That is given twice or three times a day, but I do not think the majority of people would bear that quantity.

2456. In that way in four days 3 grains of arsenic would be taken into the system?—Yes.

2457. And some of it would have perhaps disappeared?—Yes.

2458. Your statement is that 8 minims three times a day is a full dose?—I think that is the ordinary full dose you give to out-patients.

2459. It means a little more than 1-5th of a grain per day?—Yes. It is the maximum pharmacopœia dose. I particularly enquired for the dose of the Manchester physicians, and the largest dose I heard they had been given was 30 minims, a quantity which Sir William Church has given, but I find it was common to out-patients to begin and continue 8-minim doses.

2460. (*Sir William Church.*) I do not think that is common in London?—I do not think so either. I was rather surprised to find the amount was so large. I should have thought four or five minims to begin with, and then rise to eight, was the usual thing.

2461. (*Dr Whitelegge.*) What is the smallest amount of arsenic that has been found to prove harmful in medico-legal investigations—one dose or repeated doses? I am thinking of chronic arsenical poisoning?—I have known $\frac{2}{3}$ of a grain bring a person within an ace of her death.

2462. That you would consider an acute case?—Yes.

2463. There are no figures you can give to us about chronic arsenical poisoning, are there?—No, except exceptional cases. I think Dr. Dixon Mann will tell you about a servant of a friend of his to whom he gave a 5 minim dose of liquor arsenicalis, which would be equal to something less than 1-20th of a grain, three times a day, and she had arsenical rashes on the second day. But that is an exceptional case. I think one of the Americans says that the smallest dose which has produced decidedly poisonous symptoms was about something less than half a grain given in divided doses for several days.

2464. (*Chairman.*) Half a grain per day for several days?—No, half a grain in total. But that is very exceptional.

2465. (*Dr. Whitelegge.*) The arsenical poisoning we have under consideration in connection with this epidemic is one of very small doses, is it not?—I do not know. We do not know how much the beer contained which most of them drank, and how much they drank. I know in going round the Crumpsall Infirmary I asked each patient how much they took, and they would say, "How can we tell you, doctor? Anything we could get." One man, a man out of work, admitted 15 pints a day, which is nearly two gallons. That was his usual tipple.

Heavy drinkers affected by the epidemic.

2466. (*Chairman.*) That is within a pint of two gallons?—I have not seen the case myself, but I know a brewer's man in the Liverpool district where the beer contained on analysis of two samples 1-7th and 1-6th of a grain per pint respectively per gallon, and he drank usually, he said, two gallons per diem.

2467. Six pints, therefore, will contain a grain of arsenic?—Yes. He took, according to his own account, assuming the beer when he began to suffer contained the same amount, two grains of arsenic per day.

2468. Was he poisoned on the first day?—No.

2469. Did he get very ill on the first day?—No; he suffered from neuritis after drinking the beer for some time. Then you must remember that the man who drinks that large quantity also must excrete a large amount of urine, and as arsenic is chiefly excreted by the urine the presumption is that it very quickly ran through him. The arsenic must have been in a very limited condition.

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2470. (*Sir William Church.*) It is also probable, is it not, that the beer did not always contain that amount of arsenic?—It is probable it did not. When he was ill, a former assistant of mine examined the beer, and I saw the results of two samples of beer taken on two separate occasions. One was ·14, and the other ·17 of a grain per pint.

2471. One-sixth of a grain per pint is one and a-half grains per gallon, and that ·17 of a grain per pint is one and a-third grains per gallon?—Yes. It must be taken into consideration with regard to this epidemic that the beer was only taken at that one particular time, and it is quite a matter of speculation whether the beer always contained as much, or less, or more than on those particular days when Mr. Groves and others stopped the beer. The beer that had been brewed two or three months before would be all consumed, as these light ales are consumed within a fortnight of their being brewed, very often.

2472. How many specimens of beer have shown so large a proportion of arsenic as that?—I do not know. I did not myself analyse any of these highly arsenicated beers in Manchester, but I should have thought you had evidence that they did contain, some of them, over a grain per gallon.

2473. (*Sir William Church.*) One and a-half grains. Practically that was the amount found in the case I have mentioned.

Maximum quantity arsenic found in beer.

2474. (*Chairman.*) We have not heard of as much as two grains per gallon, but we have heard of as much as one and a-half grains per gallon in Liverpool. You give us in one case one and a-third grains, and in another one and a-half grains per gallon?—Yes.

Tests for arsenic in beer.

2475. Have you anything to say about the detection of arsenic in beer and its quantitative determination?—There are three tests commonly employed for the detection of arsenic when mixed with organic matter in small amounts, and they have been employed for estimating its amount. The results thus obtained are, however, estimates only, good approximations at the best, and not reliable absolute determinations of amounts. In beer, with a limited amount of material, say, one-third of a quart—which has been a very usual amount to be sent to the public analyst—and the arsenic present in the proportion of a few hundredths, or even tenths of a grain per gallon, absolute and accurate determinations of the quantity of arsenic present are impossible, and approximate estimates only can be made. When present in the proportion of a grain and upwards per gallon, the arsenic may, however, be separated as a weighable sulphide. The tests referred to are Gutzeit's, Reinsch's, and Marsh's tests. Gutzeit's test, based upon the liberation of arsenetted hydrogen, and the yellow colour produced by the action of this gas upon mercuric chloride, is delicate, subject to the same limitations as Marsh's test, and may mislead, since other substances besides arsenetted hydrogen strike a yellow colour with mercuric chloride. Unfortunately, when the colour is produced the test cannot be pushed further for confirmation that the yellow colour is due to arsenic. Marsh's well-known test in its modern modified form is very delicate, except in the presence of some sulphur compounds. It needs great care and much time, skill, and experience to work it successfully, and avoid error; and it is troublesome for beers. It should, however, be used where estimates of minute amounts of arsenic are needed, and by way of confirmation. Reinsch's test is about as delicate as Marsh's test, is easier to perform, more rapid, less liable to error, and more reliable than the other two tests mentioned. It succeeds where the other tests may fail, that is, in the presence of sulphur compounds. It succeeds when you have present the yellow sulphide of arsenic. It is not a quantitative test, but may be used to ascertain whether arsenic is present or absent in more than a given small proportion, and roughly an estimate of quantity must be made from its result. It is applicable with care when the arsenic is present in the form of its higher oxide—the arseniates—when properly applied, but these are, perhaps, never found in beer—at all events as accidental contamination. By it (as also by Marsh's test) the arsenic may be obtained in visible crystals, and these may be subjected to further confirmatory tests. The reasons why Reinsch's test was recommended by the Brewers' Commission were these:—We found that Marsh's test, which was being generally used in Manchester, was giving much trouble; that beers brewed in fresh, cleansed apparatus, and partly from arsenic—free sugar, and even all malt and hops, often contained

arsenic; that it was desirable to use a simple test by which each gyle of beer, and even each barrel of beer could be readily tested; and that provisionally a limit might be set to the quantity of arsenic in safe beers. These were the immediate problems before us, and we had to advise of Dr. Miller and the chemists working under him for the brewers as to what was advisable under the circumstances. We put this limit provisionally in conference with Dr. Delepine, Dr. Coutts, and others, at 1 per million of arsenious oxide—0·07 grain per gallon—or 1-14th grain per gallon. The now well-known test was eventually laid down in a form to meet these wants, for the use of the brewers' chemists, so that these might readily separate beers into two classes—those containing less than 1 per million of arsenic which might be passed into commerce, and those which ought to be rejected, or subjected to further analysis. The test has succeeded admirably, and in reality causes the rejected of beers containing more than one part of arsenic per two million of beer—about 1-30th grain per gallon; and in skilled hands its delicacy is even very much greater than this. I have in no case found arsenic by Marsh's test in beer where I have not also found it by Reinsch's. Using this test, I find that by far the larger proportion of beers sold in London and the southern counties are arsenic-free; but that beers sold in several parts of the kingdom contain small quantities of arsenic—generally proportions which would not, as I believe, prove injurious to health. I may mention 1-200th of a grain, 1-100th of a grain, or 1-50th of a grain, or 1-30th of a grain per gallon. It was the discovery that some beers—even all malt beers—contain small quantities of arsenic that led us to investigate brewing materials generally; and this investigation is not completed. It involves the examination of hops, malt, grain, yeast, coal, coke, etc. It is now easy to obtain brewing sugars free from arsenic; it is not, however, so easy to obtain arsenic-free malts. This subject we are working at. I have examined large numbers of jams and sweetmeats—generally made, I believe, with imported glucose—for arsenic, but in no case have I found any arsenic.

2476. (*Sir William Church.*) I should like you to tell us about what numbers of these jams and sweetmeats you examined?—I think I can give it to you approximately.

2477. Were they obtained in London or in the country generally?—In London and the southern counties. In January and February last I examined 59 samples of jams and sweetmeats and marmalades, not a very large number.

2478. Could you tell us at all what food substances are likely to be contaminated with arsenic? You have had great experience, and I should like to know whether you have ever found any food substances contaminated with arsenic?—In cases where sulphuric acid is used you may find it, but I do not find it in any food stuffs practically, that is, in an appreciable amount. If one takes huge quantities of material, one may get a very minute trace of arsenic, but if you take any reasonable quantity, say four ounces of sweets and so on, you are generally not able to detect any arsenic. I have, in years gone by, found it in sweets which have been coloured, but of late years I have found none.

2479. Have you found arsenic in syrups which are used for making temperance drinks?—No; I have examined a good many syrups of late, but I have not found any arsenic in them.

2480. Or in effervescing drinks made with kalis and tartaric acid?—I have not examined any for a long time. Sometimes I have found a litle lead in them. The quantity of arsenic present in those must be very minute, but, of course, they are subjected to the same accidents as glucose. There is, however, this difference, I believe: I am told that those things are chiefly made with foreign glucose, and we know, from old experiments made 25 or 30 years ago, that the glucoses then were very impure as compared with the present day. They did occasionally contain arsenic, but in late years we have entirely lost sight of it.

2481. Have you examined imported glucose?—No; I did not undertake any part of that investigation.

2482. (*Professor Thorpe.*) Did you have reason to believe the sweets you examined, the confectionery and the jams, were made with imported glucose?—All I know is that I am told that the imported glucoses are chiefly employed, but I do not know that of my own knowledge.

2483. Do you know anything about the colouring matters which are used in connection with confectionery, whether they are liable to contain arsenic?—I have not found it in them.

2484. Do you know that the vendors of such articles usually obtain guarantees from the manufacturers that they are free from arsenic or other deleterious products?—Yes; they employ a skilled chemist to advise them on those matters. I have had it alleged in cases of death that it was from the coloured sweets children had eaten, but I found no arsenic, and when I administered the colouring matter in large quantities to animals, I found it as a rule innocuous. Of course, there are certain colours which are injurious.

Arsenical beer solely responsible for the epidemic.

2485. I think we may summarise what you have told us in this way, that you are of opinion that this outbreak of arsenical poisoning is to be entirely attributed to beer, to beer which has been made from glucose, itself made by means of sulphuric acid containing arsenic?—Yes.

2486. Are you of opinion that the outbreak is practically wholly to be attributed to that cause?—I know of no other cause.

2487. Are you also of opinion that there is no reason to suppose that other forms of food or drinks contain arsenic in quantities to alarm the public mind?—I am of that opinion.

2488. (*Dr. Whitelegge.*) Would there not be the same risk as regards other articles of food into which glucose enters?—Yes.

2489. Do you regard the recent epidemic as an accident?—Yes.

2490. Which accident might have happened to glucose destined for other consumption than that of beer?—Yes; I think I may say that those connected with food products, beer, and so on, have relied on the fact that every glucose manufacturer—and I think there are only 10 or 11 in this country—employed skilled assistance and skilled advice.

2491. But one did not, we gather?—The advice was not effectual. He was supposed to have employed it. I do not attend to apportion any amount of blame, but there was a lack of scientific supervision there.

Expert committee's test.

2492. The expert committee's test was intended as a provisional measure, was it not?—Yes.

2493. Am I right in supposing that the degree of delicacy that has been assigned to it, first as showing one part in a million, and latterly as showing still more minute fractions, depends on the amount of liquid taken—that if the amount of beer were doubled it would be twice as delicate?—No, I do not think it would.

2494. Not even if evaporated down?—No. With regard to the application of that test, when we evaporate large quantities down we introduce a difficulty in the way of manipulation. But I know that if you take 1-100th of a grain, and add it to beer, and operate on 200 cubic centimetres you may at once detect it.

2495. Assuming for the sake of argument that arsenic were present in beer in the form of arsenious acid, would this test reveal its presence?—Yes. If you have sufficient acid. That is where it usually fails. You want sufficient acid, and long boiling.

2496. (*Chairman.*) Sufficient hydrochloric acid?—Yes.

2497. And how long boiling?—We employed 45 minutes. If you employ 10 minutes or a quarter of an hour, and you have arsenic acid present, you fail to detect it.

2498. Will three-quarters of an hour's boiling deposit all the arsenic on the copper?—I cannot say. It does not take all of it out, but it does take a sufficient quantity to enable you to detect it easily. I might explain that the reduction of the arsenate depends on the presence of some reducing agent: generally it is a trace of sub-choride of copper dissolved by the hydrochloric acid used. You must have some reducing agent present. It might be that in beers the sugars exercise a reducing effect.

2499. If you used a sufficient quantity and boil it for a long time?—You do not boil it down much.

Quantitative determination of minute quantities of arsenic in beer

2500. It would be too difficult for practical purposes except in rare cases; but still it would not be possible to boil down two or three gallons of beer to quite a small quantity, say, a quarter of a pint. It would be a long process perhaps?—You get it exceedingly syrupy, and then you get charring.

2501. Would there be a difficulty in getting the whole arsenic out by some proper chemical test, supposing it is syrupy, thick, and all the arsenic remaining in it?—You

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must oxidise the organic matter and get it clear, and then you must employ Marsh's test or precipitation as the sulphide; but when you have very minute quantities of arsenic the sulphide, although insoluble, is sufficiently soluble to prevent the formation of precipitate when you have minute fractions of a milligramme present.

2502. But supposing you push it to the very utmost, and boil it down until it is dry, and then char it, you could volatilise the whole arsenic out of it, could not you?—You can by distilling that char with hydrochloric acid.

2503. So that there is no impossibility in taking a large quantity and finding all the arsenic in it?—No, by distilling it with hydrochloric acid.

2504. It is a difficult process, but within the reach of chemical skill?—Yes.

2505. To get the whole of the arsenic in four or five gallons of beer?—Yes; but when you remember that we were advising the brewers as to how they should test their product such a test was out of the question.

2506. I quite understand. I think Dr. Whitelegge spoke of the boiling, and I wanted just to make sure that boiling down would succeed to any extent; but it is obvious that it is not a method practicable in ordinary work?—Yes.

2507. (*Professor Thorpe.*) I think Dr. Stevenson thought he was asked in reference to the process he was describing.—(*To Chairman.*) I think you yourself wished to know whether it would be possible after boiling down beer to get arsenic out by some process.

(*Witness.*) May I say in answer to that, that of course you can boil down beer, get a solid residue, distil that with hydrochloric acid, and get the whole arsenic in your distillate. Then with Marsh's test you may get it out, or if it is present in a larger proportion, you may precipitate it as a sulphide and weigh it, but you must have something beyond a small amount to get the sulphide.

2508. (*Chairman.*) That would be a way of finding whether there is as much as 1-200th of a grain per gallon?—Then you would have to use Marsh's test.

2509. But you could do it?—Yes. If you have to separate 1-200th of a grain by boiling down and distilling, and precipitating, you have such a volume of liquid that you would not be able to get the precipitate down or collected.

2510. It would be almost impracticable, but if the research was needed to test beer to the very utmost it could be done?—Yes.

Arsenic in malt.

2511. There is the question of how much is due to arsenic in malt. You have said it is now easy to obtain brewing sugars free from arsenic, but it is not so easy to obtain arsenic-free malts. Can you tell us how much arsenic per gallon has gone into beer through the malt alone?—Not from my own experiments; but I know that Dr. Miller, who has carried out the experiments, has found as much as 1-40th of a grain of arsenic per pound of malt.

2512. How much would that give to the gallon of beer?—If it was brewed altogether from malt it would give 2 and 1-3rd times that. Multiply 1-40th by 2 and 1-3rd, and you will get the amount in the beer, 2 1-3rd pounds of malt being used for a gallon of beer. That is beer of the standard gravity. It would be something like 1-16th of a grain in a gallon.

Affinity of yeast for arsenic.

2513. (*Sir William Church.*) We have also had information that in the process of brewing there is a waste of arsenic; that is to say, you do not find the calculated amount in the finished beer that you should have from what is in the ingredients?—The amount in the sulphuric acid does not go into the sugar, the char and other processes taking it out. In the process of brewing undoubtedly the yeast has a selective power for arsenic, and the yeast, as the brewers will tell you, acts as a gauge for the beer. It appears to take up the arsenic in appreciable amounts, and to purify the beer. And then the yeast employed for brewing other beers communicates the arsenic to them, but in a very diminished amount.

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2514. (*Chairman.*) Do you think such yeasts being sold to bakers is a source of danger in respect to the bread?—I think not.

2515. The quantity of arsenic in the yeast would be so small used for bread that it would not give any appreciable quantity?—I think Dr. Niven—probably you have had his evidence—had a great many breads examined early on in the epidemic, and I don't think he found any appreciable quantity of arsenic in them. That is what I should expect.

Beer in gredien should examin arsenic

2516. We have seen the great difficulty of detecting small quantities in the finished beer. If the substances put into the beer are separately examined could we keep out arsenic, or put only a very small quantity into the beer?—Yes.

2517. Supposing we have performed practical tests on the malt and the hops and the yeast and the brewing sugar, if any is used, then can we be sure that there will be less than 1-100th of a grain per gallon in the beer?—I should not like to pledge myself to 1-100th of a grain, but it would be very small. I should think that probably you might bring it to double that amount—1-50.

2518. Could you bring it to a smaller amount than is perceptible by the most delicate use of the Reinsch test?—No; I can detect 1-50 of a grain per gallon by the Reinsch test.

2519. (*Professor Thorpe.*) Do you mean to imply that if you apply the tests severally to the various things, the cumulative effect of having to let slip some quantity of arsenic which was not detected would be that the finished beer would contain as much as 1-100th of a grain?—I did not quite mean that—that if you examined all the things separately; but until malt is made with greater care than it is at present you may get 1-50th of a grain per gallon. When you exclude gas coke especially, and the malt is cleansed, and so on, you may reduce it to a very small amount. By the exclusion of arsenical fuels for drying the malt and by care in preparation you may reduce that to practically nothing; and it is the same with regard to the sugar and the hops, but not much hop is used in each brew, and I do not think hops add any considerable amount. If you examine all those separately, and exclude arsenic, your finished beer will contain—I do not like to pledge myself at present, but I should say not more than 1-50th grain per gallon, and probably less than 1-100th.

2520. (*Chairman.*) So that we can probably secure that the beer contains less than the smallest quantity perceptible to the Reinsch test?—I do not know.

2521. If you secure the purest materials by practical methods, can we assume that the arsenic would be less than would be shown by the Reinsch test?—I do not know, because the Reinsch test will often discover less than 1-100th of a grain per gallon. I do not like to limit the test.

Analy beer b analys before epiden

2522. (*Dr. Whitelegge.*) Has it been the practice amongst public analysts to look for arsenic in beer prior to the epidemic?—I believe not. I am a public analyst, but unfortunately I had not any beer to examine for months before this epidemic. I should think as a rule they would not. I know they thought this was done under the Excise, who had power, they believed, to stop the use of injurious ingredients.

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2523. Do you think that at the present time, and in future, public analysts would examine samples of beer submitted to them under the Sale of Food and Drugs Act, for arsenic?—I am sure they would.

2524. As a matter of routine?—Yes.

SIXTH DAY.

AT WESTMINSTER PALACE HOTEL.

Friday, 15th March, 1901.

PRESENT:

The Right Hon. LORD KELVIN (in the Chair).

Sir WILLIAM CHURCH | Professor THORPE.

Dr. WHITELEGGE.

Dr. BUCHANAN, *Secretary*.

STATEMENT on behalf of MESSRS. NICHOLSON and COMPANY.

(*Mr. Simpson.*) My lord, may I, on behalf of Messrs. Nicholson and Company, chemical manufacturers, of Leeds, hand to your lordship's Commission a statement which has been prepared? And in doing that, I should like, on their behalf to express their obligation to the Commission for the consideration which has been shown to them, and is proposed to be shown to them, in postponing at any rate some part of their examination. When I say that only on Saturday last we finished a second inquest of something like ten or eleven days, in which their position was subjected to the very severest criticism, your lordship will understand how much they appreciate the consideration that has been shown to them. My lord, I understand that the rule of the Commission is that counsel or solicitors should not appear before you. We do not wish in any way to infringe that rule, but might I suggest that it might be of service at a later period of the Commission, inasmuch as there is a large mass of papers in connection with this matter, which are within my knowledge (having conducted the case on their behalf), that I might be allowed, if it be necessary, simply to attend for the purpose of to some extent assisting my clients and the Royal Commission by the production of any documents, or by giving any other information that might be of service to the Commission.

(*Chairman.*) Certainly; the Commission will be glad if you will attend on such occasions, and be ready to give information.

(*Mr. Simpson.*) If your lordship pleases. Then I understand that the arrangement is that this statement should be handed in now on behalf of my clients. If the Commission could see their way to it—although I do not press it strongly on their behalf—to postpone even the public reading of that document until the action with Bostock's has been disposed of, it might be a convenience; because then we should avoid raising before this Commission any contentious matter as between us and Messrs. Bostock. If the Commission could see their way to do that, to take the statement and not at present to publicly read it, to leave both the statement and its cross-examination over until the Bostock action has been disposed of, when we shall have dealt with all the contentious matter—and this is not a convenient place to deal with that—it might facilitate matters. 15 Mar. 1901

(*Chairman.*) The Commission are willing to receive the statement which you now put in, and to postpone to a suitable time the public reading of it, and the putting of any question upon it that the Commission may desire to put.

(*Mr. Simpson.*) If your lordship pleases. Then I will put this statement in, and say that my clients feel it their absolute duty to give the Commission every assistance in every way that is possible; and I am very much obliged to your lordship.

(*Chairman.*) It must be understood that the postponement shall be till a convenient and suitable time. We cannot undertake any indefinite postponement.

(*Mr. Simpson.*) I should think we should have this action of Bostock disposed of, in the ordinary course of legal procedure, not later than a couple of months hence, and I suppose your Commission will be sitting at any rate until then.

(*Chairman.*) The Commission, of course, cannot give a pledge to postpone this matter until the final settlement of the Bostock case, but I say we will postpone it until a reasonable and suitable time for reading it occurs and putting questions upon it.

(*Mr. Simpson.*) We cannot reasonably ask for more than that, my lord, and I am very much obliged to you. (*Mr. Joseph Nicholson handed in the statement of his firm referred to by Mr. Simpson.*)

Dr. J. TATHAM (of the Registrar-General's Office), called; and Examined.

2525. (*Chairman.*) We shall be obliged if you will give us any information that you can give with reference to the recent epidemic; that is, evidence which has been reported to you, and any other points which have come under your notice?—I attend here at your request in order to furnish you with such information as can be gleaned from the National Death Register with respect to the mortality from certain causes in England and Wales which are now the subject of enquiry by your Commission. Since receiving your lordship's letter I have had the advantage of perusing the most instructive report on arsenical poisoning recently submitted to the Local Government Board by Dr. Buchanan, and, as a result, I have been able to form an idea as to the kind of information which will be useful to your Commission, on this subject. I should mention that up to the present time neuritis has not been separately classified in the returns of the General Register Office. Multiple or poly-neuritis is classified under the heading of "nervous disease." Arsenical neuritis under the head of "Arsenical Poisoning"; alcoholic neuritis goes to "alcoholism."

2526. So arsenical neuritis is a name of old standing?—Well; it is a name of some considerable standing, but up to the present time it has not been separately classified in the official reports; it has been classed to poisoning by arsenic. *Dr. J. Tatham.*

2527. Has there been any difficulty in respect of distinguishing between arsenical neuritis and alcoholic neuritis?—May I explain to your lordship? About the middle of last year, when abstracting the deaths in England and Wales for the year 1899, we noticed a considerable excess of deaths returned under the head of neuritis. This was earlier than the date at which we in London heard of the epidemic of arsenic poisoning in Lancashire. Increase in deaths from neuritis in 1899.

2528. Perhaps a year earlier?—Not a year, but some months; two or three months, perhaps.

2529. It was in 1899 that your attention was drawn to it?—Yes. The deaths referred to are those occurring in 1899. Towards the end of that year we noticed a considerable excess in the number of deaths reported as

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from neuritis, and as I say, this was some time before we in London heard that an epidemic of neuritis in connection with arsenic poisoning had occurred in the North of England.

Special classification of neuritis deaths in 1900 in progress.

2530. Those deaths were returned simply as neuritis, were they; or were they under the head of alcoholic neuritis?—Some of the cases were referred simply to neuritis, others to alcoholic neuritis. When we came to abstract the deaths for 1900 I made arrangements that the deaths from neuritis should be separately classified in all possible detail. The abstraction of these deaths for 1900 is now in process, and by the end, or shortly after the end, of May I hope to have that process complete. With your permission I will give you particulars with respect to the information which I hope to be able to submit to you shortly after the end of May:—(1) The number of deaths directly attributed to poisoning by arsenic, by lead, and other mineral poisons; (2) The number of deaths definitely ascribed to alcoholism, as well as those frequently found to be associated with intemperance, such as multiple neuritis, hepatic cirrhosis, other affections of the liver, and syncope; (3) The number of cases in which death is ascribed to a combination of any of the above causes. For purposes of comparison, figures will also be submitted showing the mortality from most of the above causes, neuritis excepted, in recent previous years. I hope to be able to present that information to the Commission shortly after the end of May. It is impossible to expedite the process beyond that, because the abstracting of over half a million deaths is a serious matter, and requires very great care

2531. Then by the end of May the information can be here, you say?—Yes; I hope shortly after the end of May to have the information complete for the Commission.

2532. For what years, 1899 and 1900?—For the year 1900, the year which I think your Commission is enquiring about.

2533. Yes. Then at present there is statistical information in your Department which has been published regarding 1899?—Yes; but you see, the deaths from neuritis were not separately abstracted in that year, and consequently I cannot give you any information concerning them.

2534. But the information already published by your office regarding 1899 would indicate the increase that you tell us you have noticed?—No.

2535. The increase of neuritis cases?—Unfortunately not, because neuritis was not separately abstracted as a cause of death; it was included under the head of "nervous disease." But deaths from arsenical poisoning unquestionably will be indicated in the reports for 1899, and also those ascribed to intemperance.

2536. According to your recollection, was there an increase of arsenical poisoning in 1899?—I have not the figures before me, but I shall prepare them in due course.

2537. As to deaths from alcoholic poisoning in 1899, have you any recollection whether there was any augmentation in that respect?—I shall shortly have the whole of the figures for that year.

2538. (*Dr. Whitelegge.*) Would it be possible to give the figures, when they are completed, in quarters?—Yes, certainly; and also to give the particulars for various parts of the country, both of which I think will be useful to you.

2539. (*Chairman.*) The Commission is very anxious to know whether or not that which came to such a disastrous head in 1900 may have been going on to a less degree in previous years, and the valuable information collected in your statistical department may perhaps throw some light on that question, because for the public health it is obviously very important indeed to know whether such a commodity as beer, for instance, has, though unknown, been occasionally a source of arsenical poisoning, or of neuritis due to arsenic. Perhaps you would kindly bear that in mind. Anything that your office can give us in the way of help towards such knowledge will be highly valued?—I will do my best.

2540. (*Sir William Church.*) Can you say when the term "neuritis" was first introduced into your tables?—Unfortunately, it has not been introduced, up to the present time; we have published no figures with respect to neuritis at all.

2541. Not under the class of "nervous disease"?—Simply as one disease among many, under the class of "nervous disease," unless it is due to alcoholic neuritis, and then it would go to "alcoholism." In the case of arsenical neuritis, the death would be classed to "arsenical poisoning." But I have taken care with respect to the year 1900 to take out all those deaths under separate headings.

2542. But even the term "alcoholic neuritis" was not used, you think, in your mortality tables before the year 1886?—It has never been used in them. In the return which I am about to prepare I shall distinguish between the several forms of neuritis.

2543. (*Chairman.*) But you say alcoholic neuritis has been in use in 1900?—Not in our returns: it is a new heading.

2544. So there is no heading of "alcoholic neuritis" prior to 1900?—No.

2545. But in the death certificates alcoholic neuritis is one of the designations which has been used?—Yes.

2546. But that does not appear in your statistics?—No.

2547. (*Sir William Church.*) Could you give us an idea how long that term has been made use of in the death certificates?—As you know, Sir William, it is a term which has been more frequently used during recent years than it used to be.

2548. And therefore there is not any very great object to be gained by going back too many years?—I think not; and it would be a very troublesome and expensive process.

2549. And probably misleading?—I fear that it would. I am convinced, but I cannot prove it by figures, that neuritis is a term which is now very much more frequently used than it used to be.

2550. And in the return of causes of death in death certificates, do you find that there is frequently a change in the nomenclature used by practitioners for the same disease?—I do indeed.

(*Chairman.*) We shall look forward with great interest to what you have promised us.

Dr. F. W. Tunnicliffe, called; and Examined.

Dr. F. W. Tunnicliffe.

2551. (*Chairman.*) Dr. Tunnicliffe, you are Professor of Materia Medica and Pharmacology in King's College, London, I believe?—I am.

2552. And a member of the Departmental Committee on Preservatives and Colouring Matter in Food, etc.?—I am.

2553. You have kindly come to give us information on various subjects, and your evidence will include the researches of yourself and Dr. Rosenheim on selenium compounds as conceivable factors in the recent beer poisoning epidemic, and some other statistics?—Yes, my lord.

Examination of Nicholson sulphuric acid for selenium.

2554. Will you kindly give us your statement?—We came to the conclusion that there probably were other factors at work in the Manchester epidemic than arsenic, and for various reasons. And we directed our attention first of all to the sulphuric acid. We were fortunate in being able to obtain a sample of sulphuric acid which was sent out by the firm who sent out the arseniated sulphuric acid, and we proceeded to see if selenium were present in this acid, and we found it to be present, and in very appreciable quantities. Having done that, we further examined several other commercial sulphuric acids, and we found in them also that selenium was present, but in much smaller quantities. Then we also found, upon looking up the literature of the subject, that it was a well-known fact that selenium was present in sulphuric acid, and, indeed, already at least one other observer had found selenium in sulphuric acid in very much larger quantity, at any rate in a larger quantity than we had found it ourselves. We regard these results as of some importance, inasmuch as it appears that from time to time in commerce sulphuric acids do crop up which contain, at any rate, if they are used in the preparation of food stuffs, selenium compounds in dangerous proportion, so far as the public health,

the health of the consumers, is concerned. This seems to be the case, not only with sulphuric acids got from pyrites, but also in sulphuric acids obtained from brimstone; and quite recently my attention has been drawn to the presence of selenium in sulphurs got from Japan. These sulphurs, I believe, contain selenium and tellurium as impurities, and not arsenic. Further, the importance of selenium in this regard has indeed been recognised in so far as in the American Pharmacopœia there are instructions and regulations for testing the medicinal preparations of sulphur or selenium. I think this is of the more importance in that it seems to me—although I have a very imperfect knowledge of technical chemistry—I think that it should be a matter of no difficulty to remove selenium from sulphuric acid. That practically completes the results that we obtained so far as concerns the acids which I have to place before you. Then we went on to investigate the question of the presence of selenium in sugars.

2555. (*Chairman.*) I think we will now get some more information about the acids before we pass on to the sugars. You obtained, I believe, a specimen of Nicholson's sulphuric acid?—Yes.

2556. One specimen?—Yes.

2557. And that acid contained about how much selenious acid?—·3 per cent.

2558. That is ·3 per cent. of its weight was selenious acid?—No, it was reckoned by volume. 100cc. of the acid contained ·3 grammes of selenious acid; it was estimated as selenium.

2559. That is to say, three thousandths of its weight was selenious acid?—Yes.

2560. You reckoned the weight of a litre of sulphuric acid as how much?—We reckoned it as so much contained in so much volume.

2561. That is so much weight?—Weight contained in the volume of sulphuric acid.

2562. We understand that to mean ·3 of a gramme of nious acid per litre of sulphuric acid?—Per cent., per 100 cc. of sulphuric acid.

2563. But we have no knowledge of the volume of selenious acid?—Three grammes per litre; ·3 of a gramme per 100 cc. of acid.

2564. That same acid contained about the same percentage of arsenious acid?—Yes.

2565. (*Professor Thorpe.*) I think it is desirable that we should be precise in this matter. What do you mean by selenious acid?—SeO_2; it is quite hypothetical, but we reckoned it as SeO_2.

2566. Then had you not better call it selenium dioxide?—Yes, quite so; we mean really SeO_2.

2567. What do you mean by arsenious acid?—As_2O_3.

2568. (*Chairman.*) Do I understand you that SeO_2 is the selenious acid of your statement?—Yes.

2569. What is arsenious acid of your statement?—As_2O_3.

2570. (*Professor Thorpe.*) I suppose you mean As_2O_6?—Yes, if you like; I am quite willing to grant that to you.

2571. As_2O_6 is the true formula, I believe——

2572. (*Chairman.*) That makes no difference in the statement, I suppose?—No.

2573. You examined, I believe, several other commercial sulphuric acids?—Yes; I think about five other commercial sulphuric acids.

2574. One of these acids was implicated in the epidemic, or was said to be implicated in it?—One of the other acids was.

2575. What did you find in respect to these five?—We found quantities of selenious acid varying from ·01 per cent. to ·004 per cent. But I would like to control those numbers further before I speak definitely about them. I may say that they were relatively very much smaller quantities.

2576. One of them, and one only, was practically free from arsenic?—Yes, that was so.

2577. What would you call "practically free from arsenic"?—We got no precipitate after we treated it for a number of days with sulphuretted hydrogen.

2578. No precipitate was formed after passing it through sulphuretted hydrogen for several days?—Yes, that is so; and it has been found by other observers, too, namely, that some of these acids which do contain selenium are practically free from arsenic.

2579. (*Sir William Church.*) All the others contain arsenic as well as selenium?—Yes. *Dr. F. W. Tunnicliffe.*

2580. (*Chairman.*) Each one of those five contained some traces of selenium?—Yes; a demonstrable trace. 1 Mar. 1901.

2581. And one of them contained some selenium, but no arsenic?—Yes, that is so.

2582. The greatest amount of selenium that has been found by any observer in a commercial sulphuric acid was how much?—Two acids were examined by Drinkwater, and he found 0·4 per cent.; that is about the mean of the two acids.

(*Dr. Whitelegge.*) Do you refer to selenium or to the dioxide?—I am afraid I cannot tell you that, but it does not make much difference. I have not the reference here, but I have it at home.

2583. (*Chairman.*) By weight the selenium dioxide is chiefly selenium?—Yes.

2584. And a small weight of oxygen?—Yes.

(*Professor Thorpe.*) It is, I think, 79 of selenium to 32 of oxygen.

2585. (*Chairman.*) That is, less than half and more than one-third of oxygen?—I cannot tell you whether Drinkwater reckoned his quantity as selenium or selenium dioxide.

2586. (*Chairman.*) Who was the observer who found as much as 0·4 per cent.?—Drinkwater.

2587. Have other observers obtained similar results as to the presence of selenium in practically arsenic-free acids?—Yes, they have.

2588. Can you name other observers?—The ones I have named here are Schlachtenhauffen and Pagel; but I believe there are many other observers, too. I believe it is the fact both as regards French and Russian acids.

2589. You speak of a dangerous quantity of selenious acid—dangerous in consequence of the use of commercial sulphuric acid containing it?—Dangerous if the sulphuric acid were used for the purpose of the preparation of foodstuffs.

2590. You mean such as glucose?—Such as sugars, which I have specially in my mind.

2591. Or effervescing drinks?—I could not speak upon that subject. I do not know what would happen to the selenium under such circumstances, but I think it would be dangerous, though I cannot say anything about that now.

2592. Would it give nip to whisky or gin?—It might give colour to it.

2593. Sulphuric acid is said to be occasionally introduced, is it not, into spirits to make it more commendable to the heavy drinker?—I believe the selenious oxide would go over into the distillate, but I have not thought about that subject.

2594. Is there any difficulty, chemically speaking, in freeing sulphuric acid from selenium?—I do not think there should be any difficulty in doing so, because in the manufacture of sulphuric acid there is present at least one of those reagents which precipitate selenious acid, namely, sulphurous acid.

2595. Would sulphurous acid, when passed through sulphuric acid, precipitate selenium?—Yes.

2596. If it was made to bubble through sulphuric acid the sulphuric acid would precipitate selenium?—Yes.

2597. (*Sir William Church.*) What reasons have you for thinking that arsenic did not explain the Manchester epidemic?—Well, I have put those reasons at the end of my synopsis.

(*Sir William Church.*) Very well; I will ask you when you come to that point.

2598. (*Chairman.*) What caused you to look for selenium in sulphuric acid?—Simply the fact that we thought there was some other poison present than arsenic in the Manchester epidemic. We were not satisfied that arsenic, although it expresses, no doubt, the mass of the truth, expressed the whole of the truth.

2599. (*Chairman.*) You will give the reasons for that later, I suppose?—Yes, subsequently.

2600. (*Professor Thorpe.*) As Dr. Tunnicliffe is practically answerable for throwing this increased light upon the cause of the trouble he will not mind being made to tell all he can as to the possibility of selenium being a cause of the epidemic. I mean that this is the first intimation we have had, other than as a matter of general information, that selenium may have been at the bottom of much of the mischief?—I would not say that. I would

Selenium as a factor in causing the epidemic.

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not say it is at the bottom of much of the mischief. I simply regard it as being a factor.

2601. I think the position had better be clearly defined. May we gather from you that you think the main cause of the trouble has been arsenic, but that selenium has played a part?—Certainly; that is precisely what I think.

but subsidiary to arsenic.

2602. Although perhaps a subsidiary part?—That is not only what I think, but what I said in Dr. Rosenheim's and my own communication to the "Lancet." We used precisely that term, "subsidiary," with regard to selenium. That was in the original communication published two months ago.

Reasons for looking for selenium.

2603. What led you in the first instance to think of selenium as playing a subsidiary or as possibly playing a subsidiary part?—That again comes in at the end of the *resumé*, but I am perfectly willing to discuss the matter with you now.

2604. You are aware that what has been concerned in the manufacture of the glucose was brown oil of vitriol?—Yes.

2605. Was it the term "*brown* oil of vitriol" which awakened your suspicion?—No; what awakened our suspicion was simply this: We had to go over the whole of the literature, so far as it was then published, at the beginning of February, and the two cases which awakened our suspicion more than anything else were two cases reported in Dr. Kelynack's book, in which he said an infant suckled at the breast exhibited symptoms of arsenical poisoning. He says distinctly that Mr. Kirkby, about whose chemical methods we could have no possible doubt, could not find arsenic in the milk. That was a clean fact. We have no doubt whatever that Mr. Kirkby could have found arsenic if it had been present.

2606. (*Sir William Church.*) It was a mere matter of opinion. Was arsenic found in any of the secretions of the baby?—No. I am only telling you what aroused my suspicion individually in the first instance. And then we began to think of some other possible poison, and we simply read of the impurities of sulphuric acid. In the impurities we found selenium mentioned. That was the method of reasoning.

2607. (*Professor Thorpe.*) You might have started on any other impurity?—Certainly, and we did start with tellurium and thallium at that time. We got selenium from the chemical side, and then we looked up the pharmacological side, and we found that selenium was highly poisonous, and that was enough to go upon.

2608. It was not, then, the colour of the oil of vitriol that attracted you to it?—No. I quite appreciate what you say since we investigated this matter, and there is no doubt that if there were other cases of arsenic poisoning the colour would influence me. I observed and grasped the significance of the fact that when the selenium was removed from the acid the latter became practically colorless.

2609. I only wanted to get at what was in your mind, as to what led you on to the track of selenium?—Our knowledge of the relation between the presence of selenium and the colour of the acid is subsequent to the whole investigation. Now I appreciate what you say.

2610. We may gather from you, I suppose, that it was some clinical abnormality, or something of that kind, which in the first instance led you to suppose there was some other cause at work than arsenic?—Yes, certainly.

2611. Of course, the fact that selenium is not infrequently present in pyrites, and not infrequently accompanies native sulphur products, is well known?—Yes, quite.

2612. It is a chemical truism?—Oh, yes, that is so.

2613. It is also the fact, is it not, that when selenium is found in oil of vitriol the fact is so noteworthy that it seems to be at once the occasion of some remark in a chemical organ?—Well, now you put that to me I see the force of what you say, but I had not thought of that before. I see what you mean clearly.

2614. My point is, that although chemists are prepared to believe, on account of the constant association of selenium with the products from which sulphuric acid is derived, nevertheless when the sulphuric acid does contain it it is such an extraordinary and abnormal fact that they draw attention to it?—I quite agree with you, it is so. That is why I say in my conclusions that these acids "crop up" from time to time. I use that expression.

2615. Is that wholly original with you? Have you seen that same phrase elsewhere?—No.

2616. You are not aware that the same phrase is used in a paper by Mr. Davies in the Journal of the Society of Chemical Industry, where he draws attention to one of these sporadic occurrences of selenium?—No, I am not aware of it. I am very sorry, but this must be only regarded as a preliminary communication. I was not aware of that paper. I am very sorry if I have unconsciously used what Mr. Davies said, but I was not aware he had said it.

Dr. Tu... 15 M...

Freq... sele... sulph... acid.

2617. The point I want to get from you is that it is a very infrequent constituent of ordinary oil of vitriol rather than a constant and frequent constituent. Is that so? Is it an infrequent or a constant constituent of commercial oil of vitriol?—I should certainly say it is relatively infrequent. I am speaking of considerable proportions; I do not mean traces.

2618. You have given the quantity associated with Dr. Drinkwater's determination. Do you know exactly how Dr. Drinkwater was led to publish his remark in the analysis about the occurrence of selenium?—No, I do not.

2619. Was it not simply in regard to oil of vitriol which was used in an oil works in the purification of paraffin?—Yes, I remember now, and that the colour of the oil went wrong.

2620. The colour of the oil of vitriol was wrong?—Yes. It was, I believe, in some shale works near Edinburgh.

2621. You told us the amount as given by Dr. Drinkwater. Are you aware of a comment which was made by Dr. Lunge on that amount?—No.

2622. Do you know Dr. Lunge's work on "Sulphuric Acid and Alkali"?—Yes, I do know Dr. Lunge as being a worker on sulphuric acid and alkali.

2623. He is, I suppose, one of the first authorities on the manufacture of oil of vitriol?—I do not know of that. I would not be prepared to say that.

2624. He says on p. 145 of his book that "the amount stated by Drinkwater seems almost incredibly high." Are you aware of that statement?—No. I will carefully read the whole of Dr. Lunge's remarks on this subject.

Orig... Nich... acid exam...

2625. How did you obtain the Nicholson's acid?—Well, I am perfectly willing to tell you exactly how we obtained it, but I should not like it published. I will write down the name, but I cannot have it published very well. That is the difficulty. It was obtained from a friend who is connected with some works, who has been in the habit of getting sulphuric acid from native sulphur for a considerable time.

2626. (*Professor Thorpe.*) But this is very important. It concerns the authenticity of this acid. We cannot yet really connect these results with Nicholson's acids. What we have been concerned with is the influence of Nicholson's acid on the beer?—We go on to the determination of it in beer. There is no doubt selenium was present in the two samples of beer.

2627. But we must connect it with this particular substance——

(*Chairman.*) Write the name down, please, and hand it to Professor Thorpe. (*The witness wrote and handed in the name and particulars asked for.*)

(*Witness.*) The name I have handed in is that of the gentleman who sent us the acid, and we can get to know from him the date on which it was sent from Nicholson's. That it did come from Nicholson's there is no manner of doubt.

2628. (*Chairman.*) It is very important that the date when it came from Nicholson's should be added.—I am very certain it did come from Nicholson's, and I can get the date.

(*Professor Thorpe.*) My lord, I am in your hands in this respect. There is a statement put in. It is an allegation, and that is as far as we can get. It is alleged that this is Nicholson's acid. Now the proof of authenticity of the acid is not very obvious.

2629. (*Chairman.*) Can you obtain a certificate from the person from whom you got it as to its source and the date of his getting it?—Yes, I will.

2630. (*Professor Thorpe.*) This, I believe, is the only sample of Nicholson's acid that you have dealt with?—No, it is not. There is another sample, which contained very much smaller quantity of selenium indeed, and we obtained that also under circumstances which I am obliged to call to some extent confidential. But I can tell you how we got that one, if you like, privately.

2631. You quite understand what I want is to connect this acid with Messrs. Nicholson?—Yes. I think

there is no doubt whatever that that acid came from Nicholson's—in fact, I am certain, and that it came just before the epidemic. I think I can prove that definitely by means of the certificate which his lordship suggests. With regard to the other acid, it was a different acid entirely, the colour was different and it was different in every way. It came from Nicholson's after the epidemic. Perhaps I had better write this down also, because it is very important. (*Information written by witness and supplied to Commission.*

2632. (*Chairman.*) You say in your *précis:* "We further examined several other commercial sulphuric acids, one of which was said to be implicated in the recent epidemic. This, however, we doubt."—That is what we do doubt, and expresses what we think about it.

2633. In respect to the acid which contained 0·3 per cent. of selenious acid and a relatively small quantity of arsenious acid—0·3 per cent., have you any doubt that it was supplied by Nicholsons?—None at the time, and before the epidemic. That I shall be able to substantiate by a certificate.

2634. (*Professor Thorpe.*) Was the second acid examined for arsenic by you?—No, I do not think so.

2635. Was it not even tested?—I think it was tested. (*After reference to Dr. Rosenheim.*) It contained arsenic and the arsenic was estimated quantitatively.

2636. Can you tell me the amount?—1·4 per cent. of arsenic.

2637. In this second acid?—Yes.

2638. You say there was 1·4 per cent. of arsenic in the second acid?—Yes.

2639. (*Professor Thorpe.*) And what was the amount of selenium there?—I have got the four remaining acids, apart from Nicholson's, massed together as containing from 0·01 to 0·004 per cent. of selenium. I cannot tell you which it was.

2640. (*Chairman.*) And one of those acids you say contained 1·4 of arsenic?—Yes.

2641. Did the remainder of those four contain much arsenic?—No, not much. I cannot tell you what they contained. I have not got the figures here for the arsenic.

2642. When you speak of 0·3 per cent. of arsenious acid in the sulphuric acid as being a relatively small amount, do you mean that it is the same percentage as that of the selenium—0·3?—That is so.

2643. But being arsenic it is relatively small?—It is.

2644. Could you tell us by what methods the selenious acid was estimated in the sulphuric acid which you tested?—It was precipitated by means of sulphurous acid.

2645. What was done with the precipitated material?—It was filtered and weighed.

2646. (*Professor Thorpe.*) What is your reason for stating that the acid which you got from the place you have now indicated, the first place—this acid which did not come in the direction of Bostock's at all—was the same as that which was used in the manufacture of Bostock sugar?—Simply because it was obtained from Nicholson's at the same time. It was obviously one sample of their issue of acid.

2647. Do you know what it was characterised as when it came to you?—Yes. It was characterised as D.O.V.—distilled oil of vitriol. It was probably a purer product than the B.O.V. It was labelled D.O.V.

2648. This is important. The acid you got in the way you have described to us was D.O.V.?—Yes.

2649. That is the first of the two referred to?—Yes. It was labelled D.O.V., and that was the one which contained the 0·3 per cent. of selenious acid.

2650. What did you think D.O.V. meant?—I thought it meant distilled oil of vitriol.

2651. You are not aware, then, that it means double oil of vitriol?—No.

2652. You assumed it had been distilled?—Yes, I thought so.

2653. (*Chairman.*) Was it clear in colour?—No, it was dark in colour—about the colour of *this* book—a distinctly dark brown.

2654. Nearly the same colour as the B.O.V.?—Very nearly.

2655. (*Professor Thorpe.*) Why should it be such a dark colour if it were distilled?—I do not know. I do not know anything about it. I did not know what the D.O.V. meant. I know that it was on the label, that is all.

2656. Did you know that Bostocks used D.O.V.?—No. I knew that Bostocks used B.O.V. *Dr. F. W. Tunnicliffe.*

2657. What is the distinction in your mind between B.O.V. and D.O.V. as applied to oil of vitriol?—I thought D.O.V. was rather a purer oil of vitriol than B.O.V. That was my idea. 15 Jan. 1901

2658. Perhaps it is rather unfair to ask you this, because you are not an expert in the manufacture of oil of vitriol?—No, I am not. I can only tell you what was on the label and what I thought. I do not know really what D.O.V. means. It is Greek to me. It does not interest me.

2659. But it is a fact that Nicholson's supplied Bostock's mainly with brown oil of vitriol—that is, B.O.V.?—That I know.

2660. That is a comparatively dilute acid?—Yes?

2661. D.O.V.—double oil of vitriol—is a very much stronger acid and approximates much more to real sulphuric acid?—Yes?

2662. You took 100cc. of this double oil of vitriol for the purpose of your estimation?—Yes.

2663. (*Chairman.*) What would be the weight of that 100cc.?—I do not know. We did not weigh it.

2664. (*Professor Thorpe.*) Did you make the determination yourself?—Yes.

2665. When you poured it out of the bottle had it the viscosity and thickness of oil of vitriol?—Yes, but I did not notice the point at the time, and I cannot tell you I have seen the acid and had it in my hand, and so forth, and manipulated it.

2666. If it were what we commonly associate with the ordinary oil of vitriol it would have a specific gravity of 1·8—very nearly twice as heavy as water?—Yes.

2667. Your 100cc. would be at least 180 grammes of material?—Yes.

2668. Your three-tenths, then, is calculated on 180?—Yes.

2669. That very nearly divides it by half, does not it?—Yes.

2670. We have it from you that the acid you examined was D.O.V., whereas what Bostock's used was B.O.V., which is an acid obtained at an earlier stage in the manufacture of sulphuric acid?—Yes.

2671. D.O.V. is a product which is obtained at a subsequent stage of the manufacture?—Yes.

2672. So that you were not getting the same thing as Bostock's were using?—I did not say I was.

2673. In your *précis* I think you said, "We were able to obtain for analysis a sulphuric acid manufactured by Nicholson's, and which we have every reason for believing was used in the manufacture of Bostock's brewing sugar." What other acids did you examine other than the second of Nicholson's?—There were acids which were bought in the open market. Do you want me to tell you the names of the makers?

2674. If you can?—One was Hartmann.

2675. (*Chairman.*) Is that German sulphuric acid?—I do not know where it comes from. I am afraid I cannot tell you the names of the other makers.

2676. (*Professor Thorpe.*) Were they bought from shops or from wholesale dealers?—They were bought from wholesale dealers. They were obtained by friends of mine in the North.

2677. Were they all pyrites acid?—I think so.

2678. In these small determinations—the small amounts that you obtained—did you in all the cases weigh the selenium as such—that is to say, after reduction with sulphurous acid, or did you use any other method?—We weighed it as such. Method of testing for selenium.

2679. You weighed it as selenium?—We calculated it as selenious acid.

2680. I understood that you precipitated it by means of sulphur dioxide?—Yes, we weighed it as selenium.

2681. In every case where you estimated the amount you say you weighed it as selenious dioxide?—We weighed it as selenium.

2682. Are all your estimations selenium?—Yes, actual gravimetric estimations of selenium.

2683. (*Chairman.*) 0·3 per cent. is selenious acid?—Yes, reckoned from the amount of selenium.

2684. What have you to say about selenium in sugar?—Then we turned our attention to the sugars, and we Selenium in Bostock sugar.

Dr. F. W. Tunnicliffe.
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got a sample of invert sugar from Bostock's, and we estimated the selenium in that sugar. We found that it contained 0·1 gramme of selenium per thousand, or 0·14 of selenious acid, or one part in 7,000.

2685. Is that per thousand by weight?—Both the selenium and the sugar by weight. Then we made some experiments with regard to the behaviour of selenious acid in solutions of glucose. We found that you could get a solution of selenious acid in glucose of very considerable strength without any difficulty. Then we thought it was a matter of some interest to determine how yeast behaved in a seleniated glucose solution, and therefore we made some experiments with that object in view. We found that the yeast reduces some of the selenious acid in the solution of glucose to selenium, and becomes coloured in the process. We found further that the activity of the yeast, except in very strong solutions, was unaffected by the presence of selenious acid. These observations, so far as the yeast is concerned, are entirely in accord with those of other observers with regard to the action of selenious acid upon bacteria and upon moulds. I think that is all we did so far as sugars are concerned.

2686. (*Professor Thorpe.*) You told us that you examined two sugars which came from Bostock's?—No; one sugar came from Bostock's and the other did not come from them.

2687. Then only one sugar came from Bostock's?—One was Bostock's invert, and the other a glucose of German origin.

2688. In Bostock's invert did you determine the selenium quantitatively?—Yes.

and in German glucose.

2689. Did you in the German glucose?—No.

2690. Was there any appreciable quantity in the German glucose, do you know?—You could demonstrate its presence, but it was not present in any considerable quantity.

2691. What test did you apply in the case of the sugars, the qualitative estimation in the first instance?—We got the selenium from the sugar solution by means of a deposition upon zinc in the presence of acetic acid. Then we dissolved the selenium off the zinc by means of cyanide of potassium, and then we precipitated it and purified it by certain methods, and weighed it. So far as the qualitative detections were concerned we got it in various ways, sometimes on copper, and then removed the selenium from the copper by cyanide of potassium, and then proceeded micro-chemically with regard to it.

2692. I understand you that this determination of 0·01 per cent. which you found in Bostock's invert was made by reducing the selenium by zinc in the presence of acetic acid—how do you suppose the selenium is present there?—I do not know how it is present there. I do not know in what form selenium is present in sugar in the least; I should presume it was selenious acid, but I could not say.

2693. Do you remember if your sugar dissolved perfectly?—Yes.

2694. You would suppose that the selenium was oxidised then?—I did not suppose it was present as selenium itself. I did not understand you to mean that. I thought you meant to ask me how I thought it was present, and I did not know. I know it was present in the soluble form, and not as selenium.

2695. And you reduced it by the action of the zinc in presence of acetic acid?—Yes.

2696. It was deposited on the zinc?—Yes, you could see that. The red precipitate on the zinc is quite clear.

2697. And you dissolved it off with cyanide of potassium?—Yes.

2698. And then you re-precipitated it?—Yes, and then we got rid of the hydrocyanic acid, and took it up with alkali and oxidised it again with peroxide of hydrogen, because we found when we simply precipitated it from the cyanide of potassium we got the selenium down in a flocculent form, probably contaminated with organic matter. When it was obtained from the cyanide of potassium, or when it was re-oxidised, so to speak, and then subsequently precipitated with hydrazine sulphate, we got it down in absolutely a hard metallic form, so metallic that you could hear it scrape against the side of the glass.

2699. But still as a red precipitate?—It was quite a different form to the other form, and that is really what made it rather difficult because we weighed the selenium in one estimation in beer and then found that it was no doubt slightly contaminated with organic matter, and we have discarded that result. The two states of deposition are very different indeed.

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2700. What was the relevancy of the fact that you found selenious acid to dissolve to almost any extent in sugar?—I quite admit the idea may have been amateurish; but we wanted to see first of all whether the sugar acted upon it as such at all.

2701. Selenious acid is so soluble that it would dissolve even in water?—Yes. I do not defend the method; but we wanted to see anyhow, and we did it. Those experiments with yeast are certainly of interest. It seems that yeast does take up the selenium, and that it is a biological combination, because if you kill the yeast first it does not take up the selenium.

2702. Have you made inquiries in breweries which you supposed to be using Bostock's sugar?—No; we have made no inquiries of any breweries of any kind whatever.

2703. The object of my question was to ask whether the occurrence of these pink yeasts had been noticed?—We have made no inquiries of any kind. That will be an extremely interesting point to elucidate.

Selenium in beer.

2704. (*Chairman.*) What have you to say about beer?—We were able to obtain two samples of beer from Salford, and in this beer we were able to demonstrate qualitatively the presence of selenium, and also to estimate it. In Sample A we made two estimations, but in Sample B we have only made one estimation. The result was that we found sample A of the beer contained 6·2 milligrammes per litre, or rather more than the third of a grain per gallon reckoned at SeO_2. Sample B contained 5·8 milligrammes in the litre, reckoned as SeO_2, which equalled ·36, which is rather more than the third of a gallon of selenious oxide per gallon. This beer also contained arsenic; we did not enter into that subject ourselves, but we are informed from an independent analysis that it contained about a grain of arsenic to the gallon, each sample. I submit that these results, so far as beer is concerned, show that when selenium is present in the sulphuric acid which is used in the manufacture of invert sugar, it does come out into the beer, and in case the sulphuric acid in question should contain quantities such as those which were contained in the acid we examined, viz., 3 per cent.—I may say that the beer and the sugar had no direct relation to the original acid, so far as we are aware—it might be a very considerable source of danger to the public health.

2705. (*Dr. Whitelegge.*) It would be lessened to some extent by the action of the yeast?—To a very slight extent, indeed. We did make some estimations to see how much was taken up by the yeast, but the quantity was very small, relatively as well as absolutely.

2706. (*Sir William Church.*) Would it in all circumstances colour the yeast?—Yes, up to about 1 in 40,000 roughly; but we are continuing with that at the present time.

2707. (*Chairman.*) Would the selenious acid, SeO_2, colour the yeast?—Speaking generally, it would.

2708. (*Professor Thorpe.*) Are you inclined to tell us the names of the breweries?—I think I can tell you all about the sugars and about the brewers. One sample of invert sugar was obtained by Mr. Gordon Salamon. I had an opportunity of communicating with him, and he was exceedingly interested in the subject, and very kindly at once placed at our disposal this sugar. There is no question about this sugar; it has nothing to do with the original acid.

Origin above samp

2709. Is the sugar that you got connected with the beer which you subsequently analysed?—Only in so far as it is Bostock's sugar.

2710. It was not obtained from a Manchester or Salford brewery which brewed the beer that has been giving trouble?—I cannot tell you that. The bottle came to us from Mr. Gordon Salamon, and on the label was "Bostock's invert." That is all I know about the origin of that sample.

2711. (*Chairman.*) Do you mean a bottle of beer?—No, a bottle of invert sugar.

2712. That you obtained in connection with the beer from the Salford brewery?—No. The invert sugar was not obtained from a Salford brewery. It was obtained from Mr. Gordon Salamon, and was labelled "Bostock's invert."

2713. Did you get it with reference to any connection with the beer you had from the Salford brewery?

—In connection with it in our own minds, but not otherwise. We got it because we wished to have it in that connection.

2714. (*Professor Thorpe.*) What was the name of the Salford brewery?—I may say I am very imperfectly acquainted with the whole of the sociology of this epidemic, but I know that "Groves" is on the bottle, Groves and something else.

2715. Was it Groves and Whitnall?—Yes.

2716. Were both samples from Groves and Whitnall?—They were in Groves and Whitnall's bottles. They were in bottles marked in that way.

2717. Are you able to inform us the date of the brewing of that beer?—Yes, I am certain that it was beer implicated in the epidemic, or I dealt with it as beer implicated in the epidemic.

2718. (*Sir William Church.*) I do not think you need be reticent with regard to Groves and Whitnall, because they have been before us?—The beer was in their bottles, and was part of the original batch got for the epidemic investigation.

2719. When?—In November.

2720. Directly the suspicion of the epidemic arising from arsenic occurred?—Yes.

2721. (*Professor Thorpe.*) Was the beer draught beer put into bottles?—No; I should think it was bottled beer, because it was effervescent.

2722. Might it have been some time in bottle?—Yes.

2723. Might it have been made prior to the mischief we are talking about having become known to the public?—I should think it was bottled beer. I think that is so, Dr. Rosenheim?

(*Dr. Rosenheim.*) It was bottle beer containing arsenic and selenium—that is all we can say.

2724. (*Dr. Whitelegge.*) Just at the end of that section of your *précis* you say that in the case of Nicholson's acid and Bostock's invert it was present in the beer in poisonous quantities?—Yes.

2725. Does that mean that in the quantity found in the samples of the beer, the selenium would be poisonous?—Yes, it does mean that. It means that it would be poisonous as selenium quite apart from the arsenic.

2726. But you say "In the case of Nicholson's acid and of Bostock's invert"?—I mean that supposing a glucose or invert were manufactured from the acid containing as much selenium as the Nicholson's acid we got contained, it would be then present in the corresponding beer in poisonous quantities.

2727. There are two propositions, and you mean to cover them both?—Yes; the acid we got did not correspond either to the sugar or to the beer, nor did the sugar correspond to the beer.

2728. (*Chairman.*) Then you refer in your *précis* to further information as to selenious acid being present in the beer in poisonous quantities?—Yes. I refer to what I have to say upon the poisonous properties of this substance and its compounds.

2729. What have you to say with reference to the malt?—With regard to the malt we have done nothing whatever. But I would point out that the flue dust of certain coal and coke contains selenium and possibly by the process of kilning malt we might introduce selenium into it. That is a mere suggestion. We have had no malt and we have done nothing in that way.

2730. (*Sir William Church.*) Have you had any flue dust?—No; this is simply second-hand information from a publication.

2731. (*Professor Thorpe.*) That has no greater value, has it, than that selenium is frequently present in all flue dust obtained where pyrites of any kind has been observed—that is all it means, is it not?—Yes.

2732. (*Chairman.*) Are we to take it that selenium is generally present in pyrites when arsenic is present?—Yes, that is so, and it is present apparently in sulphur without arsenic.

2733. Is it present in Sicilian brimstone?—Yes.

2734. Is there any arsenic present in Sicilian brimstone?—I do not know about arsenic in Sicilian brimstone, but when I speak of the selenium being present in sulphur without arsenic I am speaking especially of some Japanese sulphurs which were referred to by the editor of the "Journal of Chemical Industry" at the Society of Chemical Industry; some Japanese sulphurs which have been examined contain selenium and tellurium and not arsenic.

2735. Is that Japanese sulphur a natural product?—I think so.

2736. (*Professor Thorpe.*) Mr. Gordon Salamon told us that Japanese sulphurs were characterised by containing notable quantities of arsenic?—This information I only give you for what it is worth. I am not responsible in any sense for it.

Evidence of poisonous action of selenium on lower animals;

2737. (*Chairman.*) What about the pharmacology of selenium?—This is simply a resumé of the experiments which have been made upon selenium compounds, and it seems pretty clear from them that so far as acute poisoning is concerned, selenious acid is almost identical both qualitatively and quantitatively with arsenious acid. But, so far as chronic poisoning is concerned, it seems there are certain differences, and these differences have, I think, some application with regard to the present epidemic. For instance, one of the differences is the fact that in a number of animals poisoned by arsenic and poisoned by selenium it was found that the animals became tolerant to the action of arsenic, or in other words that more arsenic had to be given to them in order to obtain the symptoms of arsenical poisoning as time went on; whereas, on the other hand, in so far as it concerns the selenium compounds, it was found that less selenious acid had to be given to produce the symptoms, and if the same quantity of selenious acid was continued the animal died. This seems clearly to show as far as the experiments go that the poisoning action of selenious acid is more cumulative than the poisoning action of arsenious acid. A further point of interest in this connection is the fact that selenious acid causes very marked wasting, and this wasting seems quite independent of any deficiency in the assimilation of food. In the case of arsenious acid poisoning the wasting is probably to some extent at least dependent upon the fact that the patients get inflammation of their stomach and intestines, and thus are not in a position to assimilate the food—the food does not actually get into the body, whereas in the case of the selenious acid, there is no doubt from exact experiments and its action upon metabolism that it causes an increased breaking down of the tissues and that the wasting is to be explained from that. I think that is all I have to say as far as concerns the action of these substances.

2738. (*Sir William Church.*) With regard to that statement you have given us of the comparison of the action of arsenic and selenium upon animals, were the same sort of animals used in each case?—Yes.

2739. The same species?—Yes. The experiments have been made on several species of animals, but when it was a question of comparison animals of the same species were compared in Modica's experiments. But these results do not rest on simple experiments on one species of animals; they cover cats, dogs, rabbits, and of course, frogs.

2740. The frog is hardly comparable physiologically with the other animals?—It does not rest upon the one species at all, but upon carnivorous and herbiverous animals, and animals of a mixed diet.

on man.

2741. Has there been a case of selenium poisoning in man?—Selenium has never been looked for as a source of poison in man. I think it will be now, and we may have some cases of selenium poisoning recorded in the future. Japtha took selenium himself, and he noticed that he lost flesh, and noticed little else, but selenium as such is only slightly poisonous.

2742. It is the dioxide that is poisonous?—Yes; and probably other compounds too, compounds analogous to the arsenic compounds.

2743. With regard to the experiments of Japtha, Weil, and others, it is quite certain that they were working with pure materials? May they not have been working with arsenic as well as selenium?—That is a matter I am not prepared absolutely to answer now. I should think that at any rate, as the experiments of Modica were made directly for the purpose of comparing arsenic with selenium——

2744. But these others?—I should think they were also; as they were done in a good pharmacological laboratory at Prague. I should think they would be careful to re-crystallise and purify their drugs. It is a thing we should ordinarily adopt, as it a recognised thing to do in pharmacological work, to see that your elements are pure.

2745. Have you made any experiments yourself;—

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Absolutely none. In the first place I have not been able to make them because of the time, and in the second place, in this country experimental work is not easy on account of the Prevention to Cruelty to Animals Act. It takes about six weeks to get a licence.

2746. (*Chairman.*) Could you give us any reference to the authorities you quoted?—Yes; I have two of the books here.

Toxic effects of selenium like those of arsenic.

2747. (*Sir William Church.*) The physiological effects as given here of selenious acid are very closely allied to those of arsenic?—Yes, they are; the acute poisoning is practically identical. These references have been already given in my *précis*.

2748. Do you know whether selenious acid, when taken, produces gastric symptoms? That appears to be a difference between the action of the two physiologically?—It does not produce gastric symptoms to the extent that arsenic does. I think that is known.

2749. (*Dr. Whitelegge.*) Is there any proof that it produces pigmentation?—The experiments have always been made on animals with hairy skins and dark coats, and of course pigmentation in the case of an animal would be very difficult to see. There is no doubt whatever that selenious oxide is reduced to metallic selenium in the tissues—that is known. Of course, the probability is that pigmentation would occur, but it is practically impossible, without you take very special precautions, to discover pigmentation in an animal.

2750. (*Chairman.*) You said that Japtha took selenium—that is not selenious acid?—No.

2751. Would selenium pass into his tissues without any part of it being converted into selenious acid by the juices of the stomach, or otherwise?—I should think it would not be converted into selenious acid. I should think it would enter into combination in the same way that arsenic does, with the neucleo-proteids, like phosphorus and arsenic.

2752. (*Sir William Church.*) I understood you to say to me that you thought selenium was harmless?—Yes, so it is—relatively harmless.

2753. Yet according to Japtha it produces wasting?—I should think that selenium is relatively non-poisonous compared with selenious acid. I especially emphasised the fact that even the metal itself produced certain symptoms.

2754. Do you remember what quantities he took?—I do not know. That was published in 1842; and I have not had the means of consulting the original authority on the subject.

2755. (*Professor Thorpe.*) If a person takes sulphur, is there any formation of sulphuretted hydrogen? Supposing you took sulphur simply as flowers of sulphur?—There is occasionally, especially in the skin, and it is excreted sometimes in the form of sulphuretted hydrogen by the skin.

2756. Has it a marked result?—If you took enough of it you would get a marked result, but not with small quantities.

2757. Has it been discovered that selenium gives rise to selenuretted hydrogen in the same way?—No. Experiments have been made on that subject by Hoffmeister, and he found that outside the body selenium does combine like tellurium, and forms a methyl selenium compound $Se(CH_3)_2$. Tellurium is excreted by the breath as a methyl tellurium which smells oniony.

2758. Does selenium give rise to a similar effect on breath?—We do not know.

2759. You do not know whether it gives rise to selenuretted hydrogen?—No.

2760. You understand the point of my question, that these things are so intolerable in regard to the nch they give?—I quite understand what you mean.

2761. Therefore, if selenium gave rise to any secondary products of this kind its presence would be known?—Yes; it would be seen at once; that is the point I have entered into very considerably. Tellurium occurs as an impurity in bismuth, and patients who take bismuth do very often complain of an oniony taste in their mouth and their friends complain of their breath. That is due to the methyl tellurium.

2762. (*Chairman.*) Tellurium, selenium and arsenic have all the property of the garlic smell?—We are not able to say that definitely of selenium, but of tellurium and arsenic we can say so.

2763. Can metallic arsenic be taken with comparative impunity?—Yes; arsenium itself is relatively non-poisonous.

2764. Is it safe to eat any considerable amount, a grain or two, of the pure metal arsenium?—I believe so, providing it is pure arsenium.

2765. (*Chairman.*) You have some general remarks on the presence of selenium compounds in the beer, and the pharmacology of this subject, in connection with the symptoms in the Manchester epidemic?—I have a few remarks to make under that head. First of all, it has been noted by many people that the doses of arsenic taken by these patients were very small; in fact, it has been questioned whether these small doses of arsenic were capable of causing the symptoms. Without expressing an opinion upon that point, I will simply say that in all probability—in fact, pretty certainly—to these small doses of arsenic must be added also a small dose of selenium, and hence these symptoms would be more easily explainable, because you would have two factors at work. Another point of interest in this connection is the almost entire absence of tolerance in the Manchester epidemic, so far as one can judge of it from the literature on the subject. We have very definite reasons for supposing that tolerance to arsenic does occur. The Styrian arsenic eaters, clinical evidence, and, in addition, exact pharmacological experiments, are all evidence that animals and human beings do become tolerant to the action of arsenic. The evidence, so far as we have it, goes to show that animals do not become tolerant to the action of selenious acid, and therefore I think the presence of selenious acid in this beer also helps us to some extent to understand the apparent non-tolerance in Manchester. Again, if we look carefully into the question of the wasting occurring in the Manchester patients, we find that a good deal of wasting occurred there apparently unassociated with intestinal inflammation, whereas the wasting due to arsenic is nearly always associated with gastro-intestinal inflammation. Here again I think the presence of selenious acid helps us to explain this, because in the case of the action of selenious acid, wasting is due to the breaking down of tissues, and not to diminished assimilation of the food. Of course, there are those two cases which are specially reported by Dr. Kelynack, in which no arsenic was found, although the symptoms were identical with those arsenical poisoning; those cases could be explained by the assumption that selenium was present in the ingesta. If we direct our attention to the many other epidemics of arsenical poisoning that have occurred, and, indeed, to the description of arsenical poisoning in text-books, we find that different kinds of arsenical poisoning are described—the paralytic form, the pigmentation form, the gastro-enteric form, and so forth. These different forms of arsenic poisoning no doubt may be due to some extent to difference in dose; but I think they may be also explained by the fact that arsenic may have been associated with selenium. The selenium has never been looked for, and therefore has never been found. But I think the aberrancy or the inconstancy of the symptoms of arsenical poisoning are due to the fact that we are not really working with pure materials, and that the poisoning is an arsenic-selenium poison, or arsenic-selenium-tellurium poisoning.

2766. Has anyone found tellurium in any of the ingredients of beer?—Not this time, as far as I am aware.

2767. But do you think it might possibly get in?—Those last remarks of mine were directed to the previous epidemic; for instance, the arsenic epidemic in bread in Bavaria a few years ago and an arsenic epidemic at Hyères. I was not referring to the Manchester epidemic, I was speaking of the arsenical poisoning in former epidemics.

2768. Was it ascertained that tellurium was present?—It was never looked for; neither tellurium nor selenium has ever been looked for.

2769. (*Professor Thorpe.*) The Hyères epidemic was a case where apparently arsenious oxide had been used in the plastering of wine?—Yes.

2770. And your surmise is that the arsenious oxide might be contaminated with selenium?—Yes.

2771. Have you any evidence of that?—No. It is the first time selenium has ever been brought forward. With regard to the toxicology of selenium, this must be regarded as a preliminary effort, as selenium has never been looked for. Now we are able to say abso-

lutely that this substance is poisonous, and that it does get into food stuffs. I think in the future we shall all be on the look-out for selenium, both toxicologists and pharmacologists. Heretofore we have not been, although I do not know why.

2772. Confining ourselves to the case of the Hyères epidemic, there the ordinary commercial arsenious oxide was apparently used in substitution of plaster of Paris?—Yes.

2773. Your surmise is that even that product might contain selenium or selenious acid?—Yes; or tellurium.

2774. (*Chairman.*) Arsenic is made on a very large scale for many purposes. Have the manufacturers or chemical experts ever looked for tellurium or selenium in their products?—I do not think so.

2775. (*Professor Thorpe.*) You yourself have not looked for them in commerical arsenic?—No.

2776. The arsenic produced, for example, in Cornwall?—No.

2777. Is it, considering the mode in which that substance is prepared, in the least degree likely that the volatilised arsenious oxide will contain selenium?—I really could not say.

2778. You are not familiar with the method of making arsenious oxide?—No.

2779. (*Dr. Whitelegge.*) What symptoms in the former epidemic do you regard as aberrant?—For instance, in the Würzburg epidemic there was only one case of paralysis recorded. That case was rather interesting, because it was in bread, and the dose approximately would be relatively constant, at any rate as compared with beer. Of course, the dose is a great fallacy in this Manchester epidemic.

2780. It is difficult to determine?—Yes; practically impossible.

2781. I understood you to quote to us some experiments in which selenium caused paralysis?—Yes.

2782. And you identified the manifestations of selenium poisoning with those of arsenic?—Generally speaking.

2783. Would not the general absence of paralysis in those results be equally hostile to selenium as to arsenic?—No, not necessarily. They might be mixed in such a way that one would counteract the other. I am simply giving that as an instance of the fact, because I think that the so-called arsenical epidemics are probably not due entirely to arsenic. We are not working with a pure substance.

2784. Is it known that the wasting caused by arsenic is due solely to the interference with assimilation?—I do not know that it is due solely to that, but I do know that it is generally associated with a diminution of assimilation. I do not think experiments have been made with regard to the action of arsenic in the same sense that they have with regard to the action of selenium.

2785. Would you expect in the case of arsenical poison conveyed by beer that there would be less irritation of the stomach and intestines by reason of extreme dilution?—I should.

2786. So that the interference with nutrition would not be so marked?—Quite so.

2787. Does it occur to you that in the history of the Manchester cases there was more wasting than is usual in arsenical poisoning?—I am afraid I could not say.

2788. I am simply referring to your remark that "the marked occurrence of wasting in the Manchester patients occurring independently of gastro-enteritis, is to be explained by the specific action of selenious acid"?—I am afraid I could not push it to that extent.

2789. (*Sir William Church.*) What makes you say, "The marked occurrence of wasting in the Manchester patients occurring independently"—was there a very marked wasting?—Yes; and in addition to that, the arsenic was taken in very dilute form, and there was relatively little amount of gastro-enteric trouble.

2790. But a large number of them were not wasting at all, were they?—I am only going by the published records.

2791. What tissues were wasting, the muscular or the fatty?—Both the muscular and fatty tissues, as far as I have read.

2792. I have seen some of these patients myself, and wasting did not appear to me to be a very leading feature?—I am only speaking from what I have read.

2793. In the same way, you say the almost entire absence of tolerance to arsenic in the Manchester patients; what leads you to think that the people were not very tolerant of arsenic? I came to a different conclusion?—Because of the fact that the small doses of arsenic continued for a certain time produced very definite symptoms in Manchester.

2794. But we have only evidence of it in some two or three thousand cases?—It is very definitely stated in Dr. Kelynack's book, that people who took small does got large symptoms.

2795. But you say "marked tolerance." The population did show, perhaps, a tolerance to arsenic. There have only been some two or three thousand cases at the most traced, and perhaps you have not seen the evidence of the amount of beer drunk in those towns?—No.

2796. (*Professor Thorpe.*) Did you read the evidence in the Manchester inquest?—Some of it.

2797. Do you remember the evidence of a man whose wife died, and who himself said he had consumed very much larger quantities of beer than his wife, who was supposed to be killed with arsenic?—I do not remember that.

2798. And that arsenic was actually found in her viscera?—I do not remember that.

2799. If that were so, that would show a considerable amount of tolerance on the part of the man?—It would.

2800. (*Sir William Church.*) The quantities of arsenical beer that we know must have been consumed were very large?—Yes.

2801. With regard to Modica's experiments showing the non-tolerance of selenium, do you know what number of experiments he made?—I think about a dozen experiments. He gave the animals the substance for about forty days.

2802. All the same animals?—Yes. He worked entirely on rabbits, poisoning some with selenious acid and some with arsenious acid. Those were the cases of chronic poisoning. Of course he made other experiments than those.

2803. That generalisation is come to from a dozen rabbits?—Yes, practically.

2804. Is it not a known fact clinically that you get very many different forms of arsenical poisoning from the administration of medicinal arsenic?—Yes.

2805. Do you think that contains selenium?—We are at present investigating that matter, the question of liquor arsenicalis and the question of the sulphur compounds of the pharmacopœia. Perhaps I put this a little too strongly, but all I wanted to emphasise was that, apart from the difference of dose, the getting of different kinds of symptoms points in the direction of the substance one is working with not being absolutely constant.

2806. Still, taking it, as I think we may, that medicinal arsenic is fairly pure, you may have a very great variety of symptoms in different individuals. You get pigmentation in some when given medicinally, you get catarrhal symptoms often in others, and in others you get gastro-intestinal trouble?—Yes.

2807. So that unless we have been in the habit of giving an impure drug, the difference in the symptoms does not go for much?—No.

2808. (*Professor Thorpe.*) There is other evidence, I think, for the substantial purity of commercial arsenic. Large quantities of it are used in certain volumetric estimations, and the nature of those estimations is such that if selenium had been there in any sensible amount the oxide of selenium would have been reduced, and the resultant selenium would have at once manifested itself?—Yes. These are only suggestions I make, and I do not attach any very great importance to them.

2809. I venture to say that you will find when you continue your inquiries that arsenious oxide from the very nature of its mode of preparation is practically almost a pure substance—almost as pure as can be made?—I say that this is very incomplete, and I do not attach any very great importance to these suggestions. They are suggestions rather than facts.

2810. (*Chairman.*) Has selenium ever been administered as a drug for curative purposes?—No, tellurium has, but not selenium.

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2811. Does tellurium appear in the Pharmacopœia?—No.

2812. Judging from all the facts that you have put before us, you consider it of great importance that selenium should be further investigated—the possibility of selenium appearing in food and drink?—I do.

Arsenic in phosphate of soda causing poisoning.

2813. I see you mentioned a case of arseniate of sodium poisoning occurring in a family in 1900?—Yes.

2814. And I see one patient took as much as 17 grains of the arseniate of sodium?—Yes.

2815. The substance in which it was taken was phosphate of soda?—Yes.

2816. Was it an impurity in the drug?—Yes.

2817. There might be a little ambiguity in this statement, because this substance might refer to the latter, but it is really to the former?—It refers to the arseniate of sodium.

2818. Was that patient killed who took as much as 17 grains?—No, he did not vomit for about 12 hours, and then he vomited and had diarrhœa. About a week afterwards he had an attack of shingles, and three weeks afterwards he got jaundice.

2819. Was that probably due wholly to the arseniate of sodium?—Certainly, the shingles and the other symptoms were, and the jaundice too, I think, in all probability. It is difficult to be quite certain about jaundice, but I think most likely it was.

2820. Did he recover from the jaundice?—Yes.

2821. Was his health permanently injured by so severe an ordeal?—It was injured for some considerable time.

2822. (*Sir William Church.*) What reason have you for thinking that the herpes was more immediately connected with it than the jaundice?—He was a bilious subject and had had jaundice before. I do not think that the jaundice was really due to the arsenic.

2823. Were there any nerve symptoms in connection with the herpes?—No.

2824. I suppose the herpes is secondary to a nervous condition?—Yes.

2825. Did he get any paralysis?—No. The people who took the arseniate of sodium were his wife, his two children, and himself.

2826. (*Chairman.*) Did they all take the same drug?—They all took an alkali powder which was prescribed containing phosphate of soda, bicarbonate of soda, and sulphate of soda, and this powder was more or less used as a constant medicament by the whole family. The children were sick immediately—I do not know how much they took—and the wife was sick immediately and had diarrhœa, and was in a state of collapse for a few days. Then she got a peculiar erythematous skin eruption. The husband, whom I know more definitely about with regard to the actual time and the actual amount taken, took 17 grains of the arseniate of sodium, and he kept it in his stomach for twelve hours. He took it at night, and was not sick until after breakfast in the morning.

2827. You mean that he vomited and got rid of some of the substance?—Yes.

2828. Seventeen grains of arseniate of sodium out of a mixture of phosphate of soda and two other substances must have involved a tremendous amount of arseniate in the phosphate?—It did.

2829. Is there a liability now to such a drug as phosphate of soda being contaminated with arsenic?—This was due, not to chemical causes, but to the fact that two drugs were dried together, arseniate of sodium and phosphate of soda.

2830. By the apothecary?—No; by a manufacturing chemist—and they got mixed. The chemist at once referred to the manufacturer, and the supply of phosphate was at once withdrawn. Fortunately we found this out in a few days. At first I thought these persons were suffering from ptomaine poisoning, as they had eaten a Russian partridge for dinner on the same evening. They got running of the eyes and nose, and that again made me think of antimony, but the analysis showed that it was not tartar emetic, but arseniate of sodium. It was a very terrible accident.

2831. (*Professor Thorpe.*) Did you trace that up?—Yes.

2832. They were simultaneously drying the two?—Yes.

2833. I ask the question, of course, because a good deal of phosphoric acid is now made directly from phosphorus?—The retail chemist was aghast at the trouble, and referred the responsibility to the wholesale chemist, and I had several interviews with the retail chemist, and that was the statement he made to me. This was in April, the week after Easter, last year. The manufacturer at once withdrew the whole of the phosphate, and that is all that happened.

2834. I suppose it is still possible, apart from that, that phosphate of soda may contain arseniate of sodium?—From chemical reasons?

2835. Phosphorus almost invariably contains arsenic, does it not?—Yes.

2836. When it is oxidised, of course it is oxidised to arsenic acid?—Yes.

2837. If you convert the phosphorus into phosphoric acid, inasmuch as the arseniate of soda and phosphate of soda are isomorphous and crystallise together, no doubt they will afterwards occur together?—Yes. This was distinctly mechanical, I believe. I only know what they tell me. Perhaps you will remember there were several cases at the same time; there was a case of a patent alkali medicine, and there were several prosecutions last spring.

2838. (*Chairman.*) Depending upon the same lot?—Yes. I know that in two other cases I was consulted with regard to it.

2839. Were there any deaths?—I think not. It was the arseniate, and the arseniate is very much less poisonous than the arsenite, though the Pharmocopœial doses are the same.

2840. (*Professor Thorpe.*) Is that true of the free acid?—I think so.

2841. I asked that question the other day, but it does not seem to be quite clear?—There have been a number of experiments made on the relative poisonous properties of the arsenites and arseniates, and I think some on the acids, and there is no doubt that the arseniates are not anything like so poisonous in the same proportion.

2842. (*Chairman.*) Will you send in the full account for our information as to the exact way in which the samples of acid, glucose, and beer were obtained, along with any letters or other documents relating thereto?—Yes; I shall be pleased to do so.

Dr. Arthur Pearson Luff, called; and Examined.

Dr. A. P. Luff

2843. (*Chairman.*) You are a physician in charge of out-patients, and lecturer on medical jurisprudence and on public health in St. Mary's Hospital, London?—Yes.

2844. And you are one of the scientific analysts to the Home Office?—Yes.

2845. You have had experience of cases of poisoning extending over twenty-five years?—Yes.

2846. Perhaps you will tell us what you know as to the beer poisoning in Manchester?—On November 24th, 1900, I was asked to join the Expert Commission of the Manchester Brewers' Central Association, to inquire into the causes of the poisoning epidemic then prevailing in Manchester, and generally to advise as to the means to be adopted to immediately stop the epidemic, and to prevent recurrences in the future. I proceeded on November 28th to Manchester, and in conjunction with some of my colleagues, commenced inquiries on the morning of the 29th. I conferred with Dr. Reynolds, Dr. Niven, Dr. Tattersall, and the resident staffs of the Manchester, Crumpsall and Hope Infirmaries, and I wish to place here on record my appreciation of the great assistance so courteously rendered by all those medical gentlemen. The same morning I saw a number of cases of poisoning at the Manchester and Crumpsall Infirmaries, and the same day I reported to a meeting of the Brewers' Association that the majority of the cases I had seen were undoubtedly cases of arsenical poisoning. I under-

stand from Dr. Buchanan that I need not repeat what I have mentioned in the next paragraph of my *precis*, as you have already had evidence as to the praiseworthy manner in which the Manchester brewers gave us full powers to act, and did everything possible to stop the epidemic, which I believe was very quickly and effectually stopped. I saw a large number of the poisoning cases at the Manchester Infirmary, the Crumpsall Infirmary, and the Hope Infirmary. The great majority of these cases were undoubtedly cases of arsenical poisoning, but modified by the diluted form in which the poison had been taken, which was of very great importance in connection with this epidemic. The diluted form in which the arsenic was taken was responsible for the symptoms not being quite in line with some of the symptoms of the recorded cases of arsenical poisoning.

2847. Is that because you found more peripheral neuritis than you would have expected if the arsenic had been taken without the beer?—If it had not been taken in so diluted a form, I should have expected more affections of the gastro-intestinal tract, which in my experience were markedly absent, which absence I should expect when the arsenic is taken in so diluted a form. Then I think the symptoms were also modified by the actual amount of arsenic taken, by idiosyncrasy, and probably by the alcohol and other compounds taken in conjunction with the arsenic. I took very careful and exhaustive notes of about forty of the cases. These notes included the symptoms and physical signs exhibited by the patients, the incidence of the symptoms, and the daily amount of beer and spirits consumed. I also obtained from the patients the names of the public-houses at which they usually consumed their beer, or from which they obtained their supplies.

2848. Will you give us a brief summary of the symptoms and physical signs?—In the great majority of cases the illness began with pains and loss of power in the feet, succeeded or preceded by tingling in the soles of the feet, and pain in the calves. In nearly all the cases the extreme tenderness of the calves was a very marked feature. In my opinion it was much more marked than in the cases I have seen of so-called alcoholic neuritis. The peculiar huskiness of the voice was also present in a large number of the patients. Amongst the common early symptoms were also tingling of and loss of sensation in the feet and hands, followed by loss of power and ataxy—that is an inco-ordination in walking and movements with a certain peculiar stepping gait. Pigmentation was one of the marked symptoms amongst the dark complexioned patients, but was only present to a very slight extent among the fair-complexioned individuals. It generally started as an erythema, a scarlatina like blush, on the upper part of the chest, thence spreading to the face and hands. This erythema was followed by pigmentation, which was especially evident in those regions where pigment normally occurs, but was also frequently present all over the body. In some cases the individual almost resembled a mulatto, as regards the colour of the skin, whilst in others the resemblance to a case of Addison's disease was very marked. Of the other skin affections, keratosis, a horny-like thickness of the skin of the feet, and occasionally of the hands, and a reddish rash at the periphery of the soles of the feet and the palms of the hands—erythromelalgia—were met with, with a good deal of pain. I have drawn up a table which is of some interest perhaps as showing the relative occurrence of the different symptoms among the cases of which I personally obtained the histories. That table shows that the commonest symptoms were the symptoms connected with the feet and with the hands. Brown pigmentation occurred in 77 per cent., or about three-fourths of the cases. Colic, vomiting, irritation of the gastro-intestinal tract, were only present in about one-third of the cases, 36 per cent. in each. It is possible that they might have been early symptoms which the patients had forgotten; but my own impression was that the colic and vomiting were perhaps more connected with the excessive amount of beer taken than with the direct action of the arsenic on the gastro-intestinal tract. Diarrhœa was present in only a very small number of cases, although that is a common symptom of acute, or sub-acute, arsenical poisoning. It showed, to my mind, that the arsenic was very quickly absorbed from the gastro-intestinal tract, and that it then produced a peculiar effect upon certain organs, especially on the nervous system, but that it did not produce much direct effect on the gastro-intestinal tract. The following table shows the different symptoms among the cases of which I personally obtained the histories:—

Pains in the feet	in 91	per cent.	of the cases.
Loss of power in the feet	,, 91	,,	,,
Tingling of the feet	,, 86	,,	,,
Pains in the calves	,, 86	,,	,,
Husky voice	,, 86	,,	,,
Loss of sensation in the feet	,, 82	,,	,,
Ataxy	,, 82	,,	,,
Characteristic gait	,, 82	,,	,,
Tingling of the feet	,, 82	,,	,,
Tingling of the hands	,, 77	,,	,,
Loss of sensation in the hands	,, 77	,,	,,
Loss of power in the hands	,, 77	,,	,,
Brown pigmentation	,, 77	,,	,,
Atrophy of the calves	,, 64	,,	,,
Dropped hands	,, 64	,,	,,
Running of the eyes	,, 64	,,	,,
Anorexia	,, 64	,,	,,
Absent knee-jerks	,, 64	,,	,,
Dropped feet	,, 60	,,	,,
Keratosis	,, 55	,,	,,
Pains in the hands	,, 54	,,	,,
Irritation of the eyes	,, 50	,,	,,
Facial neuralgia	,, 50	,,	,,
Headache	,, 36	,,	,,
Colic	,, 36	,,	,,
Vomiting	,, 36	,,	,,
Mid-sternal pain	,, 36	,,	,,
Erythromelalgia	,, 32	,,	,,
Running of the nose	,, 27	,,	,,
Erythematous rash	,, 27	,,	,,
Diarrhœa	,, 23	,,	,,
Papular rash	,, 4	,,	,,

2849. I see tingling of the feet twice mentioned, once as 86 per cent. of the cases, and again as 82 per cent. of the cases?—That is so. I ought to explain that that was where it was especially associated with this characteristic gait. I ought to have bracketed that characteristic gait with tingling of the feet, which occurred in 4 per cent. more of the cases where there was no characteristic gait.

2850. Tingling of the feet occurred in 86 per cent., and tingling of the feet, accompanied by characteristic gait, in 82 per cent.—are those the percentages?—Yes.

2851. Are they percentages of a large number of cases?—Of 40 cases. I saw a great many more, but I had not time to take the exhaustive histories that I took of those 40 cases.

2852. (*Dr. Whitelegge.*) Are all the percentages calculated on the 40?—Yes; all of them.

2853-4. How would the last item, papular rash, 4 per cent., work out in actual cases?—I think that must have been in two cases. I did not go into decimal figures, but I think I must have seen the papular rash in 4 per cent., or two cases. I always kept to entire numbers, and did not go into decimals at all. The amounts of beer admitted to have been taken varied from two pints to fifteen pints per diem, the average being about four to five pints per diem. In one case only was the amount admitted to be below two pints, and that was the case of a female, aged 42 years, who, although most carefully questioned on the subject, would only admit the consumption of two glasses of beer a day, and of four or five glasses on Saturday. I am bound to say I am somewhat sceptical as to the veracity of those statements; but although I questioned her very carefully—and, of course, in connection with our out-patient practice we get into the habit of carefully questioning persons—about the quantities consumed, I could not get her to admit any larger quantity. It is possible her symptoms might have been brought about by that small amount of beer. Amount of beer consumed in these cases.

2855. (*Chairman.*) How much would that be?—A glass there is called a gill—it is half a pint.

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2856. A glass of beer means half a pint?—Yes. Her case was one of a well-marked peripheral neuritis, together with the characteristic gait, but with an entire absence of either arsenical pigmentation or any arsenical rash. But she was not one of the dark-complexioned individuals.

2857. Would her case be distinguishable from alcoholic neuritis?—Except that the pain in the calves of the legs was much severer than what I have generally found associated with so-called alcoholic neuritis. In only five cases out of the 40 had any spirits been taken for some months, and then, according to the statements of the patients, only in small quantities, and very occasionally. I am of opinion that the alcohol of spirits was not a factor in the production of the peripheral neuritis of any of the cases under consideration. In my experience the cases of arsenical poisoning at Manchester differed somewhat from the chronic arsenical poisoning with which I have been formerly acquainted, such as that caused by arsenical wall papers and by the use of long-continued full medicinal doses of arsenic, in the marked character of the pigmentation and of the skin eruptions in so many of the cases. They also differed from cases of sub-acute arsenical poisoning in the general absence of marked affections of the gastro-intestinal tract. In my opinion the cases should be classed as intermediate between sub-acute arsenical poisoning and chronic arsenical poisoning, as formerly understood. I am also of opinion that most probably the arsenic was taken in such quantities that had the amount been taken in a smaller bulk of fluid sub-acute arsenical poisoning would probably have resulted; but that, being taken in such a large bulk of beer, there occurred a rapid absorption of it from the stomach and intestines and also a rapid elimination of a considerable amount of the arsenic by the kidneys. Another lesson probably taught by the epidemic is that the views hitherto held as to arsenic being a non-accumulative poison, will probably have to be modified. Some of the symptoms point to the fact that the arsenic must have accumulated, and have been retained in the system for a considerable period of time.

2858. (*Sir William Church.*) Was there anything in the cases that you saw that led you to a suspicion of there being any other poison present but arsenic?—Nothing whatever.

Administration of arsenic and alcohol together.

2859. Have you any opinion whether intemperance is conducive to arsenical poisoning, that is to say, that arsenic taken by intemperate persons acts more severely than on temperate people?—I think it is very probable that it does, but my experience is practically limited to one case that occurred in my hospital practice four or five years ago, where undoubtedly a somewhat intemperate person developed very marked peripheral neuritis after taking only a few doses of arsenic, but I admit that may have been a case of idiosyncrasy. I think it was not, because I then kept that patient under observation in the hospital for some time, when he took no alcohol, and some weeks later, when I resumed the administration of arsenic in the same doses as before, he did not develop peripheral neuritis, when he had undoubtedly recovered to some extent from his condition of alcoholism. That is really the only case I know.

2860. But can you exclude his attack of peripheral neuritis as being alcoholic?—Except that when he came in he showed no signs of peripheral neuritis, and had no alcohol while in hospital, yet after only a few doses of arsenic given in ordinary quantities, 6 minim doses three times a day of Fowler's solution, he developed well-marked peripheral neuritis, and at the time I attributed it to the condition of the nervous system from the result of taking alcohol. He was very readily affected by the arsenic.

2861. But at all events it is not a recognised fact, or the profession have not recognised the fact, that the undue consumption of alcohol predisposes to arsenical poisoning?—No, certainly not. In fact, I did not recall that case until the discussion recently at the Medico-Chirurgical Society, in which I took part.

Question of combination of arsenic with organic matter of beer.

2862. Have you any opinion as to the possibility of the form in which the arsenic may be in beer? Whether it enters into any fresh combination with any organic radicals or substances?—I have no knowledge whatever about that. It is possible it may be in combination with some of the organic constituents, but I have no information on that point.

2863. Do you think that it is necessary to pre-suppose such a thing to account for the effects of these small quantities of arsenic?—Not at all.

2864. (*Professor Thorpe.*) Are they consistent with its being arsenious oxide?—They are entirely consistent with that, in my opinion.

2865. (*Sir William Church.*) In other cases of arsenical poisoning you have seen, has there been this extreme tenderness of the calves?—Yes; in some of the cases certainly.

2866. You noted that before the occurrence of this epidemic?—Yes; I had noticed that in arsenical neuritis.

2867. And as being one of the distinguishing points from alcoholic neuritis?—Yes, in my opinion. There is tenderness of the calves of the legs in the so-called alcoholic neuritis, but I have not noticed it of so extreme a character as in arsenical neuritis.

2868. It seemed to me to be most extraordinary in the Liverpool cases?—It was most remarkable in nearly all the cases. I saw patients shriek sometimes if you merely touched them lightly with the fingers on the calves.

2869. Was it very persistent, lasting for a long time?—Yes. I saw some of the cases at intervals of a fortnight, and they still showed the tenderness on pressure.

2870. I saw some of the same cases long afterwards, and they were nearly as tender when I saw them as when you did?—Yes, it lasted a very long time.

2871. To what do you attribute the huskiness of the voice?—I am not sure whether that was not due to some catarrh of the mucous membrane of the larynx, or possibly it may have been due to a nerve cause. I attribute it to one of the two.

2872. Did you attribute it to the arsenic?—I think very probably it was caused by the arsenic.

2873. You attributed it either to an affection of the mucous membrane or an affection of the nerves of the larynx?—Yes, either to one or the other. This husky voice was so common that I found it in 86 per cent. of the cases.

2874. I see it comes next to the loss of power and tingling in the feet?—Yes. I saw several cases which are not mentioned among the 40 in the out-patient department at Manchester Infirmary which one could almost diagnose by the peculiar glistening appearance and slight running of the eyes, and husky voice alone before one looked at the skin of the chest.

2875. With regard to pigmentation—was it much more marked in dark complexioned people than in fair complexioned people?—Much more.

2876. Was it so marked that you think it ought to have attracted the attention of the medical profession generally who saw these cases while the epidemic was in existence at Manchester?—It is so easy to be wise after the event. I am bound to say that I think in my out-patient practice it might very probably have escaped my attention. We do not get the patient to strip as a rule in these cases.

2877. Were not many of them very much pigmented with a pigmentation similar to that which arises from other well-known causes, such as phtheiriasis?—Yes, only in some of the cases pigmentation was darker than I have seen it in any other condition except Addison's disease.

2878. But where it was not so marked could it easily have passed for what we call Vagabond's Disease?—Easily, I think.

2879. Was the distribution of the pigmentation like that in Addison's disease?—No. I never saw any pigmentation inside the mouth, which, of course, one frequently meets with in Addison's disease.

2880. Was it on the skin?—No, it was not similar, because it did not occur at points of pressure where Addison's disease especially occurs. In the women the pigmentation did not show where the pressure of the corset had been, or the garters, as in Addison's disease. There it was quite different.

2881. Were the areolæ pigmented?—Always extremely pigmented.

2882. Did you look at the axillæ—Yes, they were extremely pigmented in most of the cases I saw. The pigmentation was generally much darker in the axillæ and in the groins than on the chest and abdomen.

2883. And on the pudenda?—Yes. In the main it was always well marked about the penis and scrotum.

2884. In some of the cases I saw, curiously enough, the axillæ and groins were less dark than the other surface of the body. That is what made me ask the question?—

In a few cases I found that so, but in the great majority of the cases there was much darker pigmentation in the axillæ and the groins.

2885. So that, of course, in those cases it did resemble Addison's disease?—It did, except that one did not find it especially marked at points of pressure and on the mucous membrane.

2886. Was the keratosis you saw unique in your experience?—I have never seen it in such a number of cases before.

2887. Or to such an extent?—Nor to such an extent. It was very remarkable in some of the cases.

2888. Greater than you see in some of the ordinary skin diseases?—Much greater in my experience.

2889. That did attract attention at once when these symptoms were manifested?—Yes, that certainly attracted attention.

2890. As soon as cases of keratosis were observed by medical men in Manchester suspicions began to be aroused?—I think it was the combination of the keratosis with the herpes in some of the cases that first aroused suspicion.

2891. Amongst these 40 there seem to be no cases?—None. I saw herpetic eruptions in only three cases, but I think it may have been a fairly early symptom in some cases.

2892. Before the occurrence of this epidemic did you associate alcoholic neuritis with beer?—I must confess that, rightly or wrongly, I associated it much more with spirits than with beer. I did not dissociate it from beer drinking entirely, but I associated it, though I might have been wrong, with spirits rather than with beer.

2893. I suppose you would agree with me that in London most of the spirit drinkers would be probably beer drinkers too?—Yes. I think most of them are undoubtedly so, as far as my experience goes.

2894. (*Professor Thorpe.*) Did you hear Dr. Tunnicliffe's evidence?—I did.

2895. Are you able to throw any light from your inquiries as to whether there was any tolerance, as it was called, in the Manchester cases?—I am perfectly sure in many cases there was tolerance of arsenic shown. I am quite sure of that.

2896. Then if Dr. Tunnicliffe puts forward as evidence that this mischief is not to be attributable to arsenic alone on the ground of the almost entire absence of tolerance you think that is an unsubstantial ground?—I think so, decidedly. I think anyone who made careful inquiries on the spot would be bound to admit the existence of tolerance in many cases.

2897. Did you think yourself that the marked occurrence of wasting in the Manchester patients occurring independently of gastro-enteritis is to be explained by the specific action of selenious acid alone?—I do not think there was a marked occurrence of wasting. I differ from that statement. There was wasting in some of the cases, but I do not think there was a marked occurrence. There was a wasting in the muscles, which were partially paralysed from the peripheral neuritis, but then you get similar wasting in paralysis from peripheral neuritis of any cause—you must get a similar wasting of the paralysed muscles. Therefore I cannot agree with the statement that there was this marked degree of wasting. If I do not agree with that I could not agree with the deduction as to the selenium being a factor on that account.

2898. If you get well-marked symptoms of arsenical poisoning and you are unable to detect evidence of arsenic in the ingesta what would be your deduction—I mean if you had well-marked symptoms of arsenical poisoning such as you are accustomed to associate with arsenic?—That you are not probably testing the proper ingesta.

2899. But if you did not find the evidence of arsenic what would be your deduction then?—Possibly that you were not testing all the channels by which arsenic might be introduced into the system.

2900. You would not think the fact that you did not find the arsenic incompatible with the existence of arsenical poisoning?—Not unless it could be conclusively shown there was no possibility of arsenic being taken. But I should want some very conclusive proof that arsenic could not be taken.

2901. Have you had the opportunity of examining any of the materials—the brewing sugars, for instance?—Yes.

2902. Have you caused any of them to be searched for selenium?—None of them.

2903. Of those you have examined did all of them contain arsenic?—No, not all the sugars I have examined. For instance, I examined a number of invert sugars, and only those which had been prepared by Bostock's firm contained arsenic. None of the others contained any whatever.

2904. Have you independently examined them?—Yes, quite independently. I only speak of the actual analyses made by myself. We have not done the work jointly, but quite independently on different samples.

2905. Have you quantitative estimations of the amount of arsenic?—I have in the beers and in the malts, but not in sugars. I did not examine very many of the sugars, only some of those invert ones.

2906. I suppose you have had no samples of oil of vitriol pass through your hands, have you?—No, not through my hands—not connected with this epidemic in any way.

2907. But you have made quantitative estimations, you say, of the beer?—Yes, all of them.

2908. Have you tested the beer itself for selenium?—I have not tested directly, but I think I am in a position to state to the Commission, if they wish for the information, that I believe all these samples of beer to be free from selenium. I can give my reasons for that statement. Although I have not tested directly for selenium I have what I think is a very good reason for believing that selenium is absent in appreciable quantities as compared with the arsenic from all the samples of beers.

2909. Are those beers which were brewed, for example, by Groves and Whitnall?—Several of them. They were beers which were collected in Manchester by inspectors under the Sale of Food and Drugs Act between the 21st November and the 28th December. Several of them were brewed by Groves and Whitnall. I have the names of all the brewers.

2910. What is the evidence, then, that you are able to give us on which you base the supposition that no selenium or selenious compounds were present?—It is this. When this question of selenium cropped up, I saw it stated in that first paper published by Dr. Tunnicliffe that selenium was not to be detected by the Marsh test, and I thought it would be advisable to mix a small quantity of selenious acid with arsenicated beers, and see if it in any way affected the character of the arsenical deposit obtained in the Marsh test. I found to my surprise—because it was quite new to me—that when I added small quantities of selenious acid to arsenical beers or to beers I knew to be pure, to which I also added arsenic, that the character of the deposit by the Marsh test was always entirely different when selenious acid was present. There was a vermilion red character about it. None of the deposits from these beers which were taken between November 21 and December 8 in Manchester show any indication of a vermilion deposit; they are all the pure arsenical deposits such as one gets in the standard tubes when working with known quantities of arsenic. I admit that my experiments are in no sense exhaustive, but it is from that alone that I infer that these beers, which undoubtedly contained arsenic in some considerable quantities, contained no appreciable amount of selenium, although I did not directly test for selenium.

2911-2. (*Chairman.*) Had you used the Marsh test before the suggestion of selenium was made?—Yes. I was employing that for the so-called estimations of arsenic in beer.

2913. So that you could not have failed to see the brilliant scarlet colours before you were even thinking of selenium?—I conceive not.

2914. (*Professor Thorpe.*) I suppose the vermilion colour is due to an extremely finely divided selenium?—Either selenium or possibly selenium in combination with arsenicum, but I do not know anything about it. I should think most probably it is finely divided selenium itself; it is the colour that one produces by precipitation.

2915. One is, of course, interested to know how it gets there. You will correct me if I am wrong, but if you add selenious acid to the Marsh apparatus, presumably zinc and sulphuric acid?—Yes?

2916. That would form seleniuretted hydrogen?—Yes.

2917. Which would be decomposed by the heat of the tube?—Yes.

2918. Decomposed into hydrogen and selenium?—Yes.

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2919. And the selenium would be deposited in an extremely finely divided condition, giving the red colour you speak of?—Yes.

2920. Is that the theory of the origin of the red colour, do you think?—That is my view of it.

2921. You say that you never noticed this peculiar colour in any Marsh reaction you had previously obtained?—No, not with any of the beers.

Chronic arsenical poisoning apart from the epidemic symptoms.

2922-3. (*Dr. Whitelegge.*) You have had experience of other cases of chronic arsenical poisoning apart from these?—Yes.

2924. Is the dose, so far as has been ascertained by analysis, unusually small to give rise to symptoms? No, I think not.

2925. You spoke of the clinical appearances being somewhat modified in connection with the epidemic, and you mention as one illustration the absence of gastro-intestinal irritation?—Yes.

2926. Does any other peculiarity suggest itself to you?—No; that was the principal one, the absence of the gastro-intestinal symptoms. I cannot say that I just now recall any other.

2927. There was nothing peculiar in the frequency of the occurrence of peripheral neuritis, for example?—No.

2928. It was not more frequent in connection with these cases than you would expect from the ordinary run of chronic arsenical poisoning?—No; not more frequent.

2929. You say you have had forty cases on which you base your table; were those observed by yourself?—By myself. I have the notes here which I took at the bedside.

2930. Was that at a late period of the epidemic?—These were taken mainly from the 29th November until the beginning of December. I took a great many of these notes on the 29th, and others quite early in December. I could not tell you the exact date now, as I have not the book with me, but I think somewhere about the 3rd or 4th of December.

2931. And the patients who came under your observation would have been drinking arsenical beer for several months?—Very probably, from what we have learned.

2932. Do you think it would have made much difference in the statistics of symptoms if the observation had been made at an earlier period? You mention, for instance, that herpes was an early symptom usually?—When it was observed it was in all probability an early symptom, but I am not prepared to say that herpetic eruptions occurred at all in a large number of the cases; because we were able to question the patients, and they assured us they had never noticed any small water bladders on the skin.

2933. You found brown pigmentation in 77 per cent. of the cases; would you expect, from what you now know of the history of the epidemic, a similar proportion in the early stages amongst the earlier cases?—I should expect to find more erythema in the early stages, because I think the pigmentation succeeds the erythema.

2934. Is it within your knowledge that pigmentation has been less observed in cases occurring outside the Manchester area—in Staffordshire, for example?—I know nothing of that.

Elimination of arsenic from the body.

2935. Can you give us any information as to the retention of arsenic in the system?—I personally know of one case in which, although the administration of arsenic had been discontinued for six weeks, yet when death occurred at the end of that time arsenic in minute quantities was found in the body. That is the longest period within my personal knowledge, although a case is recorded in which, at the end of fifty days after the discontinuation of the administration of arsenic, arsenic was found in the body.

2936. In any organ?—It was found on that occasion in the bones. It was in connection with the Hyères epidemic.

2937. For how long after the administration of arsenic ceases can you find it in the excreta?—I have not had very extensive personal experience. I found it myself in the urine on one occasion, I think, after six days. I have not got the notes by me. My experience is not at all an extensive one on that point.

Toxic effect of arsenic and alcohol together.

2938. Do you attribute an important part to alcohol as predisposing to arsenical manifestations?—I am inclined to, but as I stated to Sir William Church my experience is rather limited to that one case that occurred about five years ago in my hospital experience; but I am inclined to, because the alcohol would so affect the nervous system as to render it the more susceptible in all probability to the action of the arsenic.

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2939. I rather meant in connection with the Manchester epidemic. Do you think that the arsenic *qua* arsenic might not have been able to produce the mischief it did if it had not been for the association with alcohol in beer?—I think that is quite probable.

2940. (*Professor Thorpe.*) Here are nine Marsh mirrors obtained from nine different brewers in the neighbourhood of Manchester—the beers of nine different brewers. Are those, so far as you can judge, normal Marsh mirrors? (*Mirrors shown to Witness.*)—I should say these are all normal ones from my experience of mirrors.

2941. So far as you can determine there is no evidence of that vermilion or red deposit which is associated with selenium?—No, I should say that these are normal ones.

Quantity of arsenic in Manchester beer.

2942. (*Chairman.*) Can you tell us about the quantities of arsenic present in the beers?—I have analysed and specially estimated rather than determined the amount of arsenic present in 24 samples of beers taken in Manchester by inspectors under the Sale of Food and Drugs Act during the latter part of November and the early part of December. The dates are from November 21st to December 8th. Several of the samples were taken on November 21st. The quantities of arsenic present varied from 1-100th of a grain to ¼ of a grain per gallon. I can, if it is wished, give the actual amounts for each one.

2943. I think it would be desirable that you should do so?—I will take them in the order in which I have them in my book:—⅛th of a grain per gallon, 1-30th of a grain per gallon, 1-10th of a grain per gallon, 1-25th of a grain per gallon, 1-100th of a grain per gallon, ¼ of a grain per gallon, 1-30th of a grain per gallon, 1-100th of a grain per gallon, 1-73rd of a grain per gallon, 1-30th of a grain per gallon, 1-9th of a grain per gallon, 1-20th of a grain per gallon, 1-30th of a grain per gallon, 1-30th of a grain per gallon, 1-40th of a grain per gallon, 1-40th of a grain per gallon, 1-55th of a grain per gallon, 1-42nd of a grain per gallon, 1-50th of a grain per gallon, 1-55th of a grain per gallon, 1-25th of a grain per gallon, 1-55th of a grain per gallon, 1-55th of a grain per gallon, 1-73rd of a grain per gallon.

Tests employed.

2944. By what tests did you determine these quantities?—I estimated the amount by the Marsh method. The quantities were not sufficiently large to allow of precipitation and weighing, and therefore it is only an estimation rather than a determination, because one has to compare the mirror with the standard mirrors and so judge somewhat roughly of the amount present.

2945. (*Professor Thorpe.*) Is that the kind of thing, a series of standard tests, that illustrates what you want to say? (*Mirrors shown to Witness.*)—Certainly I prepared a number of standard tubes similar to those, and then saw with which tube the mirror I obtained most nearly corresponded.

2946. (*Chairman.*) Could you distinguish with some degree of confidence between 1-30th of a grain per gallon and 1-40th?—Yes, there is a marked difference.

2947. Could you distinguish between 1-30th and 1-35th?—Yes, but not so accurately.

2948. And between 1-50th and 1-100th of a grain per gallon?—Yes, there is a marked difference.

2949. Would 1-100th of a grain per gallon show a very unmistakeable result on the Marsh test with the quantity you used?—Yes. I used 250 c.c. of the beer, and with 1-100th of a grain there is a very distinct deposit.

2950. What was the smallest quantity you stated?—The smallest quantity I found was 1-100th of a grain.

2951. Did every one of them have as much as 1-100th or more?—Most of them had more. There were only two that contained the small quantity of 1-100th.

2952. Were these selected specimens known to be arsenical?—No, not necessarily. They were taken by the inspectors under the Sale of Food and Drugs Act as possibly arsenical beers. These were taken with the object that they might become prosecution cases.

2953. Then were these taken from suspected beers or taken at random from beers suspected and not suspected?—I do not know in what way the inspector

under the Sale of Food and Drugs Act set to work, but he took a number of samples, taking three samples in each case; one was handed over to the public analyst in Manchester, one passed on to me, and the other one retained for reference if necessary to Somerset House.

2954. Have you the means of finding the origins of the beers?—Yes, I have them amongst my notes here—the name of the publican and the brewer and the date.

2955. I think it is very important we should have both names?—May I submit this to you—I am quite in your hands—that these are cases which may become the subject of prosecutions in Manchester. They are simply awaiting a reference to the Higher Court here in London on a point of law. One case was tried and a point of law was raised which has to be argued out here in London, and all these cases may be, of course, subject to prosecutions.

2956. We could have the information, but not for present publication?—Yes, I am perfectly willing to submit it to you. Do you wish me to read it out or submit it in writing afterwards?

2957. It will be better not to read it, but to let us have it in writing?—Certainly.

2958. It will be kept private to the Commission until there is no reason for keeping it private any longer?—I will send it to the Commission.

2959. Do you think any of those specimens were taken from beers outside the number of distinct sources that had been found to be arsenical?—I think these were all taken from public houses amongst which undoubtedly cases of arsenical poisoning had arisen.

2960. Have you ever examined similarly other beers from different quarters?—No, I have not. I have restricted my examinations entirely to these beers. I have not been examining other beers.

2961. (*Sir William Church.*) These 24 beers were, I imagine, taken from houses to which certain cases had been traced?—Yes, I take it that is so.

2962. So that that accounts for there being arsenic present in every sample?—Yes, I think so. Of course they were taken at the time that the epidemic was just being suspected, on the 21st of November.

2963. (*Chairman.*) Do you consider that 1-100th of a grain of arsenic in beer could have produced such symptoms as you have described?—I do not

2964. You think the quantity must have been larger than 1-100th of a grain per gallon to have produced any of these symptoms?—In my opinion it certainly must have been greater than that.

2965. Could 1-50th of a grain per gallon produce such symptoms?—I believe not. I believe that the amount must be over 1-20th of a grain per gallon to be capable of producing any symptoms. It is, of course, only a surmise, but it is based on my knowledge of arsenic and on my knowledge of the administration of arsenic, and I think that the quantity must exceed 1-20th of a grain per gallon to be capable of producing poisoning effects.

2966. (*Sir William Church.*) Still, the idiosyncrasy of individuals to the action of arsenic is very great?—I would not say it is very great. It is great in a few cases, but it is exceptional, in my experience, to find idiosyncrasy. When you do find it, it may undoubtedly be very great.

2967. We have had evidence given before us that 1-50th of a grain has produced very marked symptoms?—That must have been an exceptional case. The case I know of where a small quantity produced marked symptoms was the one in which 15 minims of Fowler's solution were administered in five 3-minim doses. Fifteen minims would be about 1-7th of a grain.

2968. (*Professor Thorpe.*) How is tolerance to be explained except on the ground of idiosyncrasy?—I think that tolerance to a drug which is administered repeatedly in small quantities may be acquired in connection with any drug.

2969. (*Sir William Church.*) Like morphia?—Certainly. A person may get accustomed to any drug if it is administered in small quantities and repeatedly.

2970. (*Chairman.*) With regard to the quantities contained in a gallon of beer that could produce arsenical poisoning or symptoms of poisoning, that depends, of course, on the amount of beer consumed?—Certainly.

2971. So that with the enormous consumption which have been unhappily proved to be practised, might not even 1-100th of a grain have been injurious?—No; I do not think even in the case of the heaviest drinkers—and the heaviest drinkers were those who consumed 15 pints a day—I did not come across anyone who took more than that. Of course, there may have been some, but I did not come across any.

2972. A person could not poison himself by 1-100th in a gallon, even by such excess of drinking as 15 pints a day, day after day?—Not in that diluted form, because I think it would be so rapidly eliminated. It would be very different if he took the same amount of arsenic in a smaller bulk of liquid, such as when he is taking it as medicine.

Greater fatality in women.

2973. (*Sir William Church.*) Have you any explanation to offer of there being so many more fatal cases in the women than in the men?—I think to a certain extent it was that the women, and a good many of them were excessive beer drinkers, were not able to work off the combined effects of the beer and the arsenic as the men did who were employed in heavy labour.

2974. What do you mean by working off the effect?—I myself take it that the alcohol, certainly in some of the cases, in the women predisposed to make the arsenic more active in its effects, especially on the nervous system, and that the women not doing, as the majority of them did not do, any very active work, the alcohol of the beer had a much greater effect upon them than when similar quantities were taken by men employed in actual labour.

2975. The heavy work leading to a free action of the skin and perspiration, you do not think that has anything to do with the elimination of arsenic?—I think it has something to do with the elimination of arsenic. I think certainly arsenic is eliminated by the skin, because large quantities of arsenic have been found in the skin.

2976. Retained in the skin?—Yes, and possibly being eliminated by desquamation. In the scales coming off from the skin large quantities of arsenic have been found.

2977. It is also the case that alcoholic neuritis is more severe in women and more fatal in women, is it not, than in men?—That is so; and again I attribute it to their not taking the amount of exercise and doing the heavy work that men do.

Test of Brewers' Expert Committee provisional.

2978. (*Chairman.*) Then as to the test devised by the expert committee of the Manchester Brewers' Association, have you anything to say about that?—This modification of Reinsch's test was adopted as a result of a series of most carefully-planned and conducted experiments. My experience as to the delicacy and reliability of the test is that for the protection of the public health, and at the same time to allow the brewers to legitimately carry on their trade, it was the best test that could be devised. By means of that test, one part of arsenic by weight in 1,500,000 parts of beer—equivalent to 1-20th of a grain of arsenic per gallon—could readily be detected, and that proportion does not by any means indicate the limits of delicacy of the test. I am of opinion that any beer passed by this test would not, as regards the presence of any minute trace of arsenic in it, cause the slightest harm to persons consuming that beer for a period of several months. I wish to emphasise that I, for one, only intended that test to be a provisional one. We had to deal with an immediate danger, and had to protect as far as we could the public health, and at the same time see that the brewers were not absolutely debarred from supplying their beer. As a provisional test, I considered that that was one which absolutely safeguarded the public, and I stated that beers passed by that test, in my opinion, could do no harm to persons consuming those beers for a period of several months I do not think it would be right for them to go on consuming it necessarily for years and years.

2979. Might not that test pass beer containing 1-25th of a grain per gallon? You said that this test shows that arsenic to the extent of 1-20th of a grain per gallon could be readily detected.—Yes.

2980. But that proportion does not by any means indicate the limit of delicacy. Might not the ordinary test, applied with ordinary care, overlook the 1-25th? It is valid for 1-20th, but is it valid with ordinary care for 1-25th?—I should say so, decidedly. I know from my own experience that beers have been rejected by

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that test which have contained 1-25th and 1-30th of a grain per gallon.

2981. Would that test reject beer of 1-40th of a grain per gallon applied with moderate care?—It might, and it might not. I am not prepared to say it would, but I am prepared to say that it would absolutely reject a beer containing anything up to 1-20th of a grain per gallon, and I believe up to 1-25th or 1-30th.

2982. Is the danger of the 1-30th of a grain per gallon very slight to moderate drinkers?—I believe very slight, and I believe to immoderate drinkers it would not be productive of ill-effects unless consumed for a very long period of time. This test was, of course, meant as a provisional one.

2983. Do you think that to a person drinking a couple of pints per day that 1-20th of a grain of arsenic per gallon would produce any deleterious effects whatever?—I believe not, not even for a period of some months.

2984. People go on for years drinking beer moderately, and some not moderately?—I am not at all prepared to say that there should be even that amount always tolerated in beer. Of course, our work at the time was to stop a serious epidemic, and to provide a test which would allow of the beer that was being consumed for some little time to come being a safe beer. But I am not prepared at all to say that any arsenic should be permitted in beer.

2985. (*Professor Thorpe.*) You are not prepared to recommend that test as being, so to say, a statutory test?—Certainly not.

2986. But you put it forward simply as a provisional test?—Only that. It was not, so far as I am concerned, ever meant to be otherwise.

Further work of Brewers' Expert Committee.

2987. (*Chairman.*) Have you anything to add to your statement?—I have examined a large number of samples of malt, cokes, and coals for arsenic; but as this work, as well as similar work that is being conducted by my colleagues of the Expert Commission of the Brewers' Association, is not yet completed, I should like to have my evidence on that matter deferred. Before venturing to give any advice as to the best methods of preventing the occurrence of arsenic in beer, it is obviously necessary that we should make ourselves thoroughly acquainted with the various sources, other than brewing sugars, by which arsenic may be introduced, and which, undoubtedly, I am prepared to say is introduced into beers. We are making very exhaustive inquiries. We have been analysing now some hundreds of various things, and we think it would be better to complete all that work before giving evidence on the point.

2988. At present you prefer not to give any evidence with reference to the alleged presence of arsenic in malt?—I am quite prepared to say that I have found it in some samples of malt, and I am prepared to say I found it in one or two samples of malt in quantities which would introduce into beer, if all that arsenic went from the malt into the beer, as malt is ordinarily used in brewing, certainly more than one-twentieth of a grain of arsenic per gallon—that would be from the malt alone.

2989. Have you anything to say as to the prevention of such an outbreak in future?—I should also prefer to defer my evidence, if the Commission would permit me, because that must depend to a great extent from what sources other than brewing sugars arsenic can be introduced into beer; and until we are fully acquainted with the other sources, notably malts, we are not in a position, I consider, to advise as to the best method of prevention. I think I could at once give my opinion as to the best method of preventing it occurring in brewing sugars; but that is not the only source from which arsenic may be introduced, and it is not likely in future to be the source by which arsenic will be introduced into beers. Sugars will be so carefully watched now that arsenic will be detected. But there are undoubtedly other sources which we are looking into.

Arsenic in malt.

2990. (*Sir William Church.*) The malt in which you found a proportion of arsenic which would be represented by more than 1-20th of a grain in a gallon of beer, was that what they call screened and brushed malt?—That was not. I believe that if the malts are screened and brushed there would be very little arsenic left in them. The arsenic is mainly on the surface.

2991. I do not wish to push you in this, but would you say that it is very improbable that with any malt now in the market, if it is properly screened and brushed, more than 1-20th of a grain per gallon would be introduced into beers?—If it is properly screened and brushed I think it is very improbable that more than that could be introduced.

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2992. (*Chairman.*) Have you made any analysis of the malt dust?—I have not myself, but I got my information from others as to the fact that it is mainly present in the dust, and not in the brushed and screened malt.

2993. (*Professor Thorpe.*) Are you prepared at this juncture to recommend to us anything in the nature of a test—on what principle this limiting test should be based?—As to whether it should be the Reinsch or the Marsh?

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2994. Yes, or some other?—No, I am not prepared to say that, except that in my experience the third test, the Gutzeit, is not a test that can be relied upon—that is my experience of it. I think it will be either the Reinsch or the Marsh, or some modification of either of them, but I am not prepared to say at present.

2995. Here, for example are two tubes. One tube has been prepared in this way. Two-tenths of a milligramme of arsenious oxide, with 200cc. of water, 30cc. of hydrochloric acid, and copper of the dimensions given, have been boiled for 45 minutes, whereby it is assumed that practically the whole of the arsenic will come down upon the copper. The residue was then tested in the Marsh apparatus, and gave the reaction you see there at the top. Do not you think that such a quantity of arsenic ought not to have escaped detection? (*Tube shown to witness.*)—Yes. I think it is very remarkable, and I am surprised at the amount.

2996. (*Chairman.*) Boiling for 45 minutes with the Reinsch test did not take out all the arsenic?—No, apparently not. We never thought it would take all of it out, but we knew it would take out sufficient to detect up to that limit.

2997. By continuing the boiling with a fresh piece of copper would you be able to take out more?—Undoubtedly.

2998. Could it all be got out in that way by going on long enough?—I doubt if it is all removed. I have not experimented on that point, but I doubt if it is ever all removed by boiling, unless you get it down in bulk, and continue to add more hydrochloric acid. I am surprised that so much arsenic is left in this tube.

2999. (*Professor Thorpe.*) Here are two actual beers, with an unknown quantity of arsenic, which were boiled for 45 minutes, according to prescribed conditions, and then the residue was tested in the Marsh apparatus, and gave those results. Do not you think that is an amount of arsenic which ought not to have escaped detection?—I certainly think so. May I ask what sort of sublimate was obtained from the copper; was it a well-marked crystalline sublimate?

3000. I am not able to tell you?—This does not indicate that the test was not a good one, unless it can be shown that the sublimate, as obtained from the copper, was one which would have allowed the beer to have been passed as a safe one. I am prepared to say that, although this amount was left in the beer, yet there would have been a very good sublimate obtained from the copper, which would be quite sufficient to condemn that beer.

3001. That may be true, but the point is that the copper did not take out anything like the amount of arsenic that was present?—No; but in Reinsch's test it never does. What we said in connection with this test was that it took out sufficient always to indicate if the beer contained anything like 1-20th of a grain, or more than that, per gallon.

3002. (*Chairman.*) Has it ever been tried to use a large number of pieces of copper simultaneously in the Reinsch test?—Yes; but that is not desirable. It is far better to concentrate the arsenic upon a small piece of copper.

3003. If you use two pieces of copper in the Reinsch test, will each of them take less than one alone would have taken in the same time of boiling? Supposing you took a piece of copper of a certain size, and boiled it for three-quarters of an hour, repeating it again with all the circumstances the same with two pieces of copper, will each piece of copper take as much in the test as the one piece of copper in the previous test?—No; you will not get so much deposit on each of the two pieces as on the one, but possibly you may get rather more deposit on the two pieces together. We never thought that this test removed all the arsenic, but we found by experiment that it removed sufficient

to enable the beer to be condemned, certainly up to the limit of 1-20th of a grain per gallon, and even more.

3004. (*Professor Thorpe.*) In other words, your test is a net of which the meshes are still rather large?—Certainly.

3005. (*Sir William Church.*) You asked Professor Thorpe, and he was unable to tell you, the condition of the copper by which the beer was tested: if that beer had contained a large amount, say 1-10th of a grain, you would have got such a precipitate upon the copper that you would have been able to reject the beer from that without using the Marsh test at all, would not you?—From our experiments we know that if beer contained anything like that, whatever the amount or arsenic that might be left in the beer after boiling with the copper, there was always enough deposit on the copper to condemn the beer.

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3006. Would you condemn it on the deposit on the copper?—Certainly. I knew there was some left, but I was surprised to see from those mirrors that it was so much. There is no doubt, however, in my mind but what those beers would have been condemned by the subliming from the copper, whatever amount of arsenic was found afterwards in the beer.

SEVENTH DAY.

AT THE TOWN HALL, MANCHESTER.

Monday, 25th March, 1901.

PRESENT:

The Right Hon. Sir William Hart-Dyke (in the Chair).

Sir William Church. | Professor Thorpe.

Dr. Whitelegge.

Dr. Buchanan, *Secretary.*

Mr. Richard George Hooper Tomson, called; and Examined.

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3007. (*Chairman.*) You are secretary, are you not, to Messrs. Threlfall's Brewery?—No. I am the manager of the Manchester business.

3008. You are the first witness taken in Manchester for this local enquiry, and you wish to say that the reference that has been made in one of the papers to obstacles having been placed in the way of the Commission obtaining information is inaccurate?—Yes, certainly.

3009. How many years have you been in this responsible position?—I joined Threlfall's Brewery in 1864, and have been there ever since.

3010. As secretary all that period?—No. I joined first of all in Liverpool as one of the junior clerks, and from there I was transferred to Manchester in 186-, and I was quite a young man when I was put into the foremost position there. Our old cashier fell ill, and I have been in the principal position ever since, and really had the practical management of the business. I have had very nearly 40 years' experience.

3011. Messrs. Threlfall's Brewery are customers of Messrs. Bostock, are they not?—Yes, we have been customers of Bostock for certainly 15 years, if not longer—it may be 18 years.

3012. Is glucose used in your brewery?—No; we have not used any glucose at all of any kind or description; we have only used the two qualities of invert sugar, Garton Hill's and Bostock's, and in both instances it is the No. 1 quality, the best quality we could buy.

3013. Have you ever had any other than the best quality supplied to you?—No.

3014. Has this invert sugar that has been used in the brewery been used for brewing only, or priming, or for both?—We use it principally in the brewing, in the copper. We have primed, but only to a very small extent. 76 per cent. of our brews are unprimed, and 24 per cent. have had priming in them. That 24 per cent. is sub-divided into this: 10½ per cent. with only a quart to a barrel, and 13½ with two quarts to a barrel.

3015. Those proportions you have mentioned were in use in the brewery between June and November last?—Yes.

3016. There was no exception at that time to the usual course?—No. We have used both these sugars practically in the same proportions for many years past.

3017. With regard to different qualities of beers, which quality of beer were you in the habit of priming, and how much priming did you use in each kind of beer?—In the 8d. beers there has been no priming whatever, but in the other beers, where they have been primed, it is only used to the extent of about a quart in the best ales and two quarts in some of the common ales. That is only in a small proportion of the brews. There is very little priming in the bitter beers. It is principally in the common beers, the 6d. and 4d. beers, but even then it is only 24 per cent, that is, 76 per cent. has not been primed at all.

3017*. (*Professor Thorpe.*) In priming, do you use the amount which the Excise permit you to use, or less?—Less. Limit of priming.

3018. What proportion of the permissible amount do you use?—The quart would be about half the permissible amount.

3019. In no case greater?—No, in no case greater than the Excise allows.

3020. In no case greater than the proportion, I mean?—It depends upon how you treat it; you can use this priming to any extent if you only treat it as a "wort."

3021. As a separate brew?—Yes.

3022. Confining ourselves to the syrup for a moment?—We have never exceeded what the Excise allows.

3023. What proportion of the amount that the Excise allows you have you uniformly worked up to?—That depends entirely how you treat it. If you call it "syrup" they will not allow you to use more than something under a half gallon. If you take exactly the same solution in every respect, and treat it as a "wort" you can use any quantity of it. Excise limit may be exceeded if priming sugar is termed "wort."

3024. Of course I know that, but I think perhaps it may serve to fix our ideas if we dissociate the two operations. You can use any amount of sugar you please when you enter it as a brew and declare the gravity of it?—Yes; that is for priming. I am not speaking of the copper.

3025. The finished beer you are allowed to add a certain amount of syrup to?—Yes.

3025. We will keep those two things different. In your 8d. beer you added no priming?—None at all.

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3027. In your cheaper kinds of beers you added a certain amount just before it went out?—Yes, in 24 per cent.

3028. Of the 24 per cent. which you primed immediately before it went out with syrup, did you invariably use the amount which the Excise permits you to use?—No, less.

3029. How much less?—A quart. It would be something under two quarts they would allow. It is about three pints, I think.

Sugar obtained from another maker besides Bostock.

3030. Was that syrup invariably Bostock's?—No, Garton Hill's.

3031. Invariably Garton Hill's?—Yes.

3032. Invariably for that purpose?—Yes.

3033. (*Chairman.*) Taking all the sugar in use, how much during the period you have mentioned came from Bostock's?—I think about 12½ per cent. of Bostock's and 7½ per cent. Garton Hill's.

3034. For how many years had your firm been a customer of Messrs. Bostock?—15 to 18 years; I should think it must be the latter.

3035. And until this epidemic arose had either you personally or the firm in general any reason to suspect that there was any mischief?—None whatever. I have been in the trade all my life, and my father was, and my grandfather, and I never heard of such a thing before. It came upon us like a thunderclap.

3036. You had never the faintest suspicion?—No, not the slightest.

Action by Brewery on discovery of epidemic.

3037. Will you tell the Commission, after this discovery was made, and as soon as it was ascertained there was any danger, what steps generally were taken by your firm for the security of the consumer?—The first communication we had that there was anything really seriously wrong was from Dr. Tattersall, of Salford. He wrote on the 21st November, and asked to be supplied with samples of our malt and hops, which were, of course, sent to him. We did not hear anything more until the 23rd, on the Friday, when he said he had found nothing wrong with the malt and hops, and asked to be supplied with samples of the sugars. We also sent those. On the 24th he sent down word again that we had better stop using Bostock's sugar. Of course I went with the brewers, and we had all the stock of Bostock's put on one side, and I had the casks sealed so that they could not be used. Eventually, of course, it was all returned to the works; every barrel was sent back.

3038. Did you recover all the beer that went out to the retailers?—Yes. We stopped the use of the sugar. I am speaking of the sugar now; it comes in in barrels, and I had them sealed and sent them all back.

3039. That was the security for the sugar?—Yes.

3040. (*Professor Thorpe.*) Did you send to Dr. Tattersall at the same time Garton Hill's sugar?—Yes.

3041. You yourself had no idea which sugars were incriminated?—Not at all.

3042. You sent both?—Yes.

3043. And the only message you got was: Stop using Bostock's?—Yes.

Prosecution under F. and D. Acts.

3044. (*Chairman.*) With regard to your beer, in the first place, has any action been taken by the sanitary authority against any retailer?—Yes; 5 summonses were issued against our retailers in Manchester only, and two of those samples were taken on the 21st November, before we knew anything about it.

3045. At what dates were the summonses issued?—I think they were returnable on January 7th or 8th.

3046. With regard to the suspected beer containing this contaminated sugar, I presume a great quantity had gone out, had it not?—There was a large quantity in the retailers' cellars. They have to have quite a week or 10 days' stock in most of the houses.

3047. What steps did you take with regard to the houses?—It was on the 26th, the Monday; when I got to the office I stopped sending all the beer out, stopped the sales absolutely straight away. Our managing director came over on Tuesday, and we divided Manchester and Salford up into districts. We send our beers into a great number of towns and it was a work of no small labour—there are about 40 different towns we send our beer to. We stopped the whole of the beer with Bostock's sugar in it in Manchester and Salford by sending messengers round, and in the outlying districts, Oldham, Bolton, and those too far to reach by messenger were informed by telegrams. It cost us something between £5 and £7 for telegrams.

3048. With what result?—Every barrel was suspended. We stopped the sale first, and then a day or two afterwards we sent round and had it all destroyed.

3049. Do you know within a little what the quantity was?—I can give you the exact figures: there were altogether 5,558 barrels.

3050. Was it destroyed on your premises or both on the premises and elsewhere?—Yes, both. The consideration that weighed with us was, as I say, the fact that a large quantity of our trade is done outside Manchester and Salford. There was one thing perfectly clear, that the beer was utterly valueless, and to pay the carriage back from the outlying districts where we delivered by rail, and haul it back from Oldham, Bolton, and other districts, would be only giving an immense amount of manual labour. In some cellars it is awkward to pull ale out. We took into consideration that it was no use, and therefore destroyed it in the customers' cellars. We did not leave it to the customers to destroy; we saw it run down and destroyed ourselves in each instance.

3051. (*Sir William Church.*) Your agents went to all the houses you supply?—That is so.

3052. (*Professor Thorpe.*) You had no reason to take it back. What object had you?—It was absolutely valueless to bring it back; to haul it back from Oldham, Bolton, and all those places merely for the sake of destroying it would have been foolish.

3053. The beer having left the premises, you could not consider you had any call upon the Excise authorities to refund to you?—No, we found we could not do that; it would not do to have risked it. It would have been too great a risk, and would not have been worth the candle.

3054. (*Chairman.*) That would have created an interval of time which would have caused danger?—Yes.

3055. (*Dr. Whitelegge.*) Do the 5,000 barrels include any quantity destroyed at your own works?—Yes. There was rather more I think destroyed at customers, perhaps two or three hundred barrels more than in the works.

3056. (*Chairman.*) In consequence of this catastrophe, I presume more than ordinary steps have been taken by your firm since to prevent the recurrence of such a disaster. Could you tell the Commission what those steps are which have been taken since?—Yes. We sent every sample of ale out to be analysed. We sent some to Matthews and Lot, and a sample of every malt and hops, and ingredient that we had, and also sent samples of the ales; and they sent a telegram to us that we must stop using Bostock's. They passed all the samples of beer with the exception of one, which they said contained a faint trace of arsenic. We sent samples to Dr. Miller, who was very much more severe. He said there were some of the beers contaminated. Those were all destroyed. Those were the beers we did not send out.

3057. (*Sir William Church.*) These are in addition to the 5,558?—No; they are included.

3058. (*Chairman.*) My question rather referred to what steps you have taken since. You are referring now to everything you had in stock?—Yes.

3059. The point I was putting to you is this: since the catastrophe and the steps you then took for the destruction of your beer, what steps have you taken so as to secure absolute purity from arsenic?—We have not sent a single barrel out since December 3rd but what has been passed by Dr. Miller. He is analysing now every brew we send out. We have not parted with a single brew that has not been passed by Dr. Miller. We also sent all samples of ingredients, malts, and hops, and sugars to be analysed by him.

3060. (*Dr. Whitelegge.*) What does Dr. Miller report to you?—Of the beers now?

3061. Yes. In what terms does he report? Does he say "Free from Arsenic," or "This beer may be distributed"?—I have his reports here. He states that such and such a sample of beer "readily passes the experts' test"—*i.e.*, the test recommended by the expert committee of the Manchester Brewers' Association, which you have had in evidence.

3062. (*Professor Thorpe.*) Are the reports all constructed on the same formula?—Just about the same.

3063. (*Chairman.*) Is that a general type?—Yes. There is one very important analysis there the Commission might like to see. We had that done the other day.

"Messrs. Threlfall's Brewery Coy. Ltd., Manchester.

9th March 1901.

"Dear Sirs,

I have tested for arsenic the following of your samples, and the results are as under:—

Sample marked	P.A.	First wort, passes easily.
,,	P.A.	Last runnings, passes easily.
,,	P.A.	From hop back, passes easily.
,,	P.A.	From cooler, passes easily
,,	P.A.	From round without yeast, passes easily.
,,	P.A. 551.	First morning after fermentation, passes easily.
,,	B.	First wort, passes easily.
,,	B.	Last runnings, passes easily.
,,	B.	From hop back, passes easily.
,,	B.	From coolers, passes easily.
,,	B.	From round without yeast, passes easily.
,,	B. 552.	First morning after fermentation, passes easily.

Yours faithfully,

ALEX. K. MILLER."

3064. This is an analysis of samples?—That is what we call "Coursing the Brew right through." We do it in every stage. It gives the process which it goes through. We had, I think, two brews done in that way.

3065. (*Professor Thorpe.*) Is that a brew in which you use malt substitutes?—Yes; I think it had Garton Hill's sugar in it.

3066. (*Sir William Church.*) Do you know what Dr. Miller means by the term "pure" in some of these certificates?—I suppose it is that it has passed the test laid down by the experts.

3067. No. He said "Readily passes the expert test" in the case of three beers, and in three other cases he says it is "pure"?—I cannot explain that.

3068. (*Chairman.*) The one is the finished article, beer, and the other, which he terms "pure," is an ingredient, namely, malt?—Yes. He has used that formula all through.

3069. There are two formulæ, one for the finished article and another for the ingredient?—Yes.

3070. Up to the time of this disaster, what steps were your firm in the habit of taking in regard to analysis generally of your product, or of any sample which you were using?—We had the water analyses periodically, and I have the analysis here.

3071. I am referring to the time before November, of course?—Yes, before November, 1900. The last time we had Bostock's analysed was in July.

3072. Have you an analyst?—No.

3073. (*Professor Thorpe.*) You had Bostock's sugar examined so far back as July?—Yes.

3074. What would you have it examined for then?—Because we usually do have things examined.

3075. But for what purpose?—To see if there is any constituent in it that is objectionable for brewing purposes. We should never dream of having it analysed for arsenic. Arsenic is a matter that is not of the least value to us; it neither helps us, nor is it a detriment. I am putting aside the poisonous quality. But as a matter of help or defect in brewing, we do not care whether it is in or out. When we make the analyses we do so for the purpose of finding out any ingredient that would be helpful to brewing, or harmful to brewing.

3076. (*Professor Thorpe.*) What you mean is, you examined Bostock's "invert" for its brewing value and nothing else?—Yes.

3077. (*Dr. Whitelegge.*) So that the analysis in July would not throw any light in one way or the other on arsenic?—No. Dr. Miller came to my office and had an interview with our managing director. I was present. He put the question straight to Dr. Miller. He said: "How was it you did not find arsenic," and he said, "I never looked for it."

3078. (*Chairman.*) He never tested for it?—No.

3079. (*Professor Thorpe.*) It was Dr. Miller who examined it in July, was it?—Yes.

3080. (*Chairman.*) Now this epidemic has taken place, of course you would not be satisfied, as regards future analysis, with the test you have applied in the past—you want something of a different type?—Yes.

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3081. Can you suggest, from practical experience and connection with the trade, what test should be applied not only to the materials, but to the finished article in the future to give complete security against arsenical poisoning?—I do not think I am able to do that.

3082. We do not want you to speak as a practical chemist, for instance; but merely from your trade connection?—Our brewer submits it, roughly speaking, to a rough test. Touching Bostock's sugar, I remember in 1899, nearly two years ago, just about the end of May, that in putting this through the rough test he discovered something he did not like. He sent that sample to Dr. Miller to be analysed, and the report came down that the sample contained a portion of cane sugar. The invert sugar of Bostock's is made from cane sugar, and it really meant that it had not been properly inverted. The effect would be that it would cause the beers to be thick, and that was distinctly detrimental to brewing. It would have spoilt our beers. We stopped using it for a time. We had Major Pooley, who was chairman of Bostock's at the time, down, and he got a pretty good dressing down from our managing-director about it. Lately Bostock's sugar as far as the brewing sugar is concerned, has been good—our brewer was only telling me last spring the excellent quality they were sending us. There was practically little to chose between them and Garton Hill's as far as the brewing sugar was concerned. Garton Hill's was simply lighter in colour, and more adaptable for pale ale brewing.

Brewing value of Bostock invert satisfactory.

3083. (*Chairman.*) Does that suggest there was something wrong that you sent this for analysis? It was not your habit to subject these materials to constant analysis?—Every now and again we sent them up.

3084. You were satisfied with an occasional test?—Yes. I believe Garton Hill's was analysed some time in 1898, but we never found the slightest thing wrong with Garton Hill's, and we have dealt with them longer than with Bostock's.

3085. (*Sir William Church.*) To put it very shortly, your purpose in having Bostock's material analysed was to see that it was not adulterated, that it contained nothing that it should not contain?—That is precisely so.

3086. (*Chairman.*) Would you be satisfied in the future—I am speaking now as regards carrying on your business so as to get perfect security against any danger of this kind occurring again—would you be satisfied with a guarantee as regards each one of these materials from the manufacturer?—No; we get the guarantees. I have them here. (*Witness put in guarantees of malts, brewing sugars, etc., which stated in each instance that these materials were "free from arsenic," "absolutely pure," or "perfectly free from arsenic or other deleterious ingredients."*)

Guarantees now demanded by brewer

3087. Would you propose in the future that in addition to the guarantee you should apply the test of analysis on your own premises?—It will very likely lead to it. In brewing our beer we are never very much in love with too much chemist, and if we require analysing we send it up to London, or get an analyst outside to do the work. I think now it will eventually come to it that we shall have to have analysts. We have two young pupils coming up from Dr. Miller, one being my son, and I think we shall put down a laboratory, and submit the beers to an analytical test. If there is anything suspected we shall have it further corroborated by some higher expert. These are the sort of things we get now. (*Specimen analyses of brewing sugars put in.*)

3088. From what you know of the trade generally, do you think it would be considered injurious to their business if they were compelled to test each and all materials, in addition to having the guarantee of their purity before using them?—I do not know why it should, provided the test is a fair one.

might be made compulsory for brewer to test his ingredients.

3089. I am assuming, of course, a fair test. My point is, whether you think it would be injurious to the trade, or cause any very great extra expense in the course of your business if you were obliged to apply a secure test in each case as regards the materials you are using—say, for instance, invert sugar—that that invert sugar is absolutely pure from arsenic, before it comes into your business?—I do not think it would be, and I do think it ought to be done.

3090. In fact from your recent experience and all your firm has gone through, you would be almost inclined to do it for yourselves rather than run such another risk; that is your feeling at present?—Undoubtedly so. It might press a little bit hardly on the smaller brewers, but I do not know.

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3091-2. You buy malts now under a guarantee that they are free from arsenic?—That is so.

3093. You would not object to a separate guarantee for each consignment?—No; but we get them.

Arsenic in non-Bostock beer.

3094. After giving up the use of Bostock's products were any of your beers condemned as arsenical either by your own analyst or by others?—Yes; in three instances we found traces. Dr. Miller reported there were minute traces in three of the brews.

3095. Was that beer brewed from invert sugar or glucose?—We never use glucose. I believe in one instance it was an all-malt brew, and in the others invert sugar.

3096. Did you find it necessary to destroy these?—I do not know whether it was necessary to do it, but we did it.

3097. In your brewery do you malt for your own purposes, or buy malt largely?—We malt rather more than half, and the rest we buy.

3098. With regard to the malt you buy, I suppose you have regular people you deal with?—We buy our malt uniformly from one or two people.

3099. Can you tell the Commission who these people are?—Jones, of Shrewsbury, and Soames, of Grimsby.

3100. (*Dr. Whitelegge.*) Where are your own maltings?—At Worksop, Horncastle, and a small one at Lincoln.

3101. Have you any knowledge of the working of these places?—Yes, I know the process of malting. Of course I am not an expert maltster; I used to learn something about the process some years ago.

Coke abandoned by maltster.

3102. Do you know how the malt is dried?—Yes. In our kilns we used coke.

3103. (*Chairman.*) Do you use coke now?—We have stopped it now.

3104. When did you stop it?—After this matter came up.

3105. Before that you had always used it, had you?—Yes, principally, I believe.

3106. What are you using now?—Anthracite.

3107. I suppose the Manchester and Salford brewers use a great quantity of malt, do they not, as well as sugar?—Yes; it is the bulk of it.

3108. Can you tell the Commission where the chief part of the malt comes from?—No, I could not answer that.

3109. You could not say personally what was malted on the premises?—I do not quite follow you. Do you mean to say, brewers using their own malt?

3110. Yes?—I have no knowledge of that.

3111. (*Professor Thorpe.*) Is there much malting done in this district?—No. It will come more from Grantham, Lincolnshire, and that way. There is a great deal of malt from the Yorkshire district.

3112. (*Chairman.*) There is a great deal of malting in Norfolk, is there not?—Yes. At one time we used to malt practically all our own, but the trade has so increased that it has outstripped the malting supply.

3113. You now malt about 50 per cent.?—I daresay 45 to 55 per cent.

3114. (*Professor Thorpe.*) Has that malt been usually dried with coke or with anthracite?—Usually with coke.

3115. Hitherto it has been mainly dried with coke?—Yes.

3116. (*Chairman.*) Had you had any suspicion until lately that it was possible for malt to become impregnated with arsenic from the fumes of the coke?—It was not known to me, or to any of us.

3117. Do you suppose, taking the trade throughout the United Kingdom, there was any suspicion whatever?—Not in the least.

3118. Or, as regards any brewer, that there was that danger in the business?—No; I have never heard of it, or heard it hinted at in any way.

Guarantees in respect of malt.

3119. (*Dr. Whitelegge.*) Do you demand a certificate for the malt you buy to the effect that it has been dried with anthracite?—I do not know that we actually stipulate.

3120. It is mentioned in two of the certificates you have handed in?—I do not think we have gone so far as to say, "This must be dried with anthracite," but we take it that it is, because we have a certificate of purity.

3121. From arsenic?—Yes.

3122. (*Professor Thorpe.*) Have you had any difficulty about getting the certificates in the case of malt?—No.

3123. Have you insisted upon them, or have they been volunteered?—We have insisted upon them. I may say there are one or two samples which after buying we had analysed, and there was a very faint trace, and we would not even use them.

3124. Has the necessity of drying with anthracite affected the price of malt?—I do not think it has. It will naturally affect the price a little, because it is more expensive to use anthracite coal.

3125. Do you anticipate that will be the effect?—Yes; I daresay it will put it up slightly. It is rather a difficult thing to arrive at; of course, it does add to the cost, but whether it will be sufficient for the maltster to bear the loss of it or whether he will put it on to the consumer I do not quite know. There is a great deal of irregularity in the way the malt comes in; sometimes it is a maltster's year and sometimes a brewer's. It depends on the grain.

3126. (*Chairman.*) It will depend upon the locality also, as regards the price between the anthracite and coke?—Yes. There is the cost of the carriage.

3127. If anthracite were to be used solely for malting I presume it might stop malting in some districts, and it would go on in others where anthracite was more easily procurable?—It might be so, but I could not answer that question very well.

3128. (*Dr. Whitelegge.*) Have you any knowledge of malt samples dried by means of gas coke which have been analysed and found free from arsenic?—Some of them have.

3129. Recently?—We have had some samples passed, but it all depends upon what test they were put through. It might not have been so severe a test as they are using now.

3130. Do you mean some of the samples recently supplied to you?—No, not recently supplied.

3131. Unless they were recently supplied they would not have been examined for arsenic?—Do you mean since December?

3132. Since you have been in the habit of referring them to Dr. Miller for analysis?—In the early part of December we had some samples of the kind in question sent out for analysis.

3133. Were they passed by Dr. Miller?—No, Mathews and Lot passed them, I think.

3134. Do you remember where they came from?—Yes, Worksop and Horncastle.

3135. Would it be your own maltings?—Yes.

3136. And while you were still using gas coke?—Yes.

3137. But in spite of that you changed from the gas coke to the anthracite?—What we did was this. As soon as we had these unfavourable reports of the malt I went over with Dr. Tattersall. He asked to see our maltings and he took some samples away. We stopped malting and had the whole of the kilns cleaned down, and have been using anthracite, and since then all the samples of malt we have had have been passed as pure.

3138. (*Chairman.*) When you speak of cleaning the kilns that means that a large amount of malt dust has collected?—Yes.

3139. That would point to the importance in the future of keeping these kilns as free as possible from the collection of malt dust?—Yes. I do not know how you are going to do that. They are always brushed up and thoroughly cleaned every now and again; but for all that there will be a certain amount of dust there.

3140. With regard to the materials you use in the manufacture of beer, do your books show what particular materials were used in the manufacture of any particular beer, and in what quantities?—Yes. I brought up our brewing book. We have a record of these things. That is the system. (*Books shown to the Commission and explained by the Witness.*) *This* is the date, the number of the brew, and the quality. *These* are the quantities of malt in that particular brew; *these* are the hops used; *these* are the details, and *these* the number of barrels produced. The number of barrels produced are the bulk barrels; they are taken by the Excise and reduced to the gravity.

3141. (*Professor Thorpe.*) Is this the form prescribed by the Inland Revenue?—No, it is our own private book.

3142. (*Chairman.*) This includes all the informa-

tion to the Inland Revenue that is required?—Yes. We do not give the different malts here; but in this other book we give the different malts. (*Book shown to the Commission.*)

3143. With regard to your tied houses do you always know what brews are on the premises at any given moment?—Yes. The casks are all numbered.

3144. With regard to the retailer do you give a guarantee of purity in each case?—No; we have never done it.

3145. If a severe system of testing were necessary in the future, I suppose you would be only too glad after the test had been applied to have it placed on the barrel or bottle?—I do not see any objection to it.

3146. Having gone to the extra expense, small or great, of testing accurately so as to secure purity, you would have no objection to advertising the fact that such test had been applied and that it was guaranteed pure?—I do not see what objection could be raised to it as long as the beer was pure.

3147. My point is this: a guarantee might prove fallacious, might it not?—Yes.

3148. A guarantee of a certain material under which you buy might be fallacious, might it not?—It might be, certainly; it is possible.

3149. If you apply a severe test on the top of that as an additional security to the consumer, you would have no objection to its being advertised on the barrel?—Yes. Certified as pure.

3150. (*Professor Thorpe.*) But publicly certified?—Yes.

3151. (*Chairman.*) Have you taken any steps in applying to the Inland Revenue for return of duty on any beer?—We thought of doing it, and we stored the beer that had not been sent out, but eventually we decided not to do it, and ran it all away. What weighed with us in that respect was that we thought there would be a great deal of trouble in getting it, and the casks were suffering. It was no use getting 5s. or 6s. a barrel back in the case of a cask worth double the money. We thought therefore it was best to destroy the beer and save the casks.

3152. (*Professor Thorpe.*) You called in the Revenue officer to take note of the volume?—We notified him, but I do not think he attended.

3153. I gather you do not now intend to make a claim?—No.

3154. (*Sir William Church.*) What length of time do you think elapsed between your becoming aware of there being contaminated beer in the tied house and all of it being destroyed? It must have taken some time for you to go to all the houses. You say you sent telegrams to stop the sale of it, and then sent your own agents round to destroy it?—I should think that within a week it would be very nearly all destroyed. There might have been a few barrels left, but very few.

3155. Before it was found out that beer was contaminated by arsenic, did you ever have your malt analysed?—I do not remember ever having it submitted to an analyst such as we have had done lately. We examined the malts, but it was more for moulds, sickness, broken corns, or anything of that sort.

3156. Analysed for its quality but not for any impurities?—No, not for any impurities.

3157. Used you to have any other brewing materials analysed?—No.

3158. Did you use hop substitutes?—No.

3159. Did you use colouring malts or have them analysed?—No; we did not use colouring materials, except in porter brewing.

3160. Were the preservatives analysed?—We used phylax, but I do not know we ever had that analysed until this was brought up.

3161. Do you know in what way the materials that you got from Shrewsbury were dried?—Yes; they are all dried by anthracite coal.

3162. I presume the Grimsby malt would be probably dried with coke?—I think now they are dried with anthracite.

3163. What I am asking about is, whether you could give the Commission any information as to the custom previously?—I believe Jones has always used anthracite coal, but what Soames have done I cannot say.

3164. Have you any knowledge of the kind of fuel that is chiefly used in Norfolk?—No, I have not. I suppose they do there the same as at other kilns.

3165. It was quite unsuspected by maltsters generally that there was the possibility of this danger?—I never heard of such a thing.

3166. In your own malting do you clean the malt after it had been roasted?—Yes. We screen it. It always was screened, and of course it is screened again when it is going into the hopper for crushing. All the dust is separated, but now we are having it double screened. Screening malt.

3167. I wish to know something about what was the habit of the trade before there was any suspicion of the possibility of this outbreak occurring?—It was all screened, and a great deal of the malt dust and foreign substance taken out, but it was not absolutely all cleaned. The remainder of it was done when it was passing through the mills. The mills we use are Nalder's mills, wonderful machines. They can separate all the dust out, and they can take nails or any stones out, and only leave the malt in.

3168. Were you always in the habit of screening?—Yes. You could not use malt without.

3169. But not as effectually as is now done. There is what they call brushing as well as screening?—We are now erecting machines in our kilns for that purpose. We have never tried it. It is quite a new thing. Brushing now about to be adopted.

3170. Polishing has been only recently introduced in the malting?—Yes; it is a very recent addition. We never heard of it before this happened.

3171. Do you think this extra screening and polishing has been used by other maltsters for any time?—That I am unable to say.

3172. The malt you used to buy was also, I presume, screened?—Yes, it would be all screened.

3173. Was it satisfactorily screened?—Yes; we never had any fault to find.

3174. Do you know whether that was polished?—I should say not.

3175. (*Professor Thorpe.*) I think you told us that of the two sugars that you are in the habit of using, Bostock's and Garton Hill's, in your opinion there was practically no difference in their equivalent brewing value?—That is so.

3176. But such difference as there was was that Bostock's were inclined to be rather darker in colour?—That is so; it was always that way. Garton Hill's was always an exceptionally pale syrup. Colour of Bostock sugar.

3177. For example, would you call that dark in colour or light in colour (*sample shown to Witness*)?—I should call that a light colour.

3178. Was Bostock's usually darker than that?—I should think so, a little.

3179. Was Bostock's darker than that of late, or was it always very much of the same character?—Always very much of the same character. You are asking me perhaps something I should not answer, because I could not say. That would be for the brewers. It would not come under my notice.

3180. It would not be brought to your knowledge whether the sugar that was being introduced into your place was rather darker than usual?—No, it would not.

3181. Is there anybody from whom we could get that information?—Yes, the brewers.

3182. You have no reason to believe that of late Bostock's invert or glucose has been somewhat off colour as compared with their previous manufacture?—No. I have never heard the brewers say anything about it. I have never heard it complained of.

3183. If it were darker in colour does your knowledge enable you to say to what the darkness would be due?—No.

3184. The guarantees which you say you now get from the persons who supply you with brewing sugars are guarantees which you yourself have demanded, or have they been voluntarily supplied to you?—We have demanded them. Guarantees.

3185. Garton Hill did not give you the guarantee until you asked for it?—I do not think so. I believe we asked for them, to the best of my recollection.

3186. Is the form of the guarantee satisfactory to you?—I think so. It states: "We certify that the saccharum

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to which enclosed invoice relates is perfectly free from arsenic or other deleterious ingredients."

3187. Garton Hill's guarantee is a specific guarantee attached to every delivery?—Yes. The printed form I have read comes attached to every delivery.

3188. It is not a mere general guarantee covering all their supplies?—No; it comes with every invoice.

3189. Did the other persons who supplied you with materials give equally specific guarantees?—There is Duttson and Co., that is a porter sugar, and a very expensive one, too.

3190. With regard to that, which is stamped with the india rubber stamp; do you attach as much importance to that guarantee as you do to the other?—Yes, I should say so.

Caramel.

3191. Do you use caramel?—Yes.

3192. From whom do you get it?—I think it is Duttson's.

3193. Has that caramel been examined?—Yes.

3194. That caramel has been made from glucose?—I could not tell you what it is made from.

3195. You do not know the origin of it?—No, I do not.

Yeast of implicated brews had normal appearance.

3196. Has your attention been drawn to the occurrence of any exceptional colour in the yeast of late?—No.

3197. You yourself have seen nothing peculiar in the yeast?—No; I should have heard of it at once.

3198. No occurrence of any pink colour, or anything of that kind?—No.

3199. Nothing exceptional?—No, nothing exceptional.

3200. (*Dr. Whitelegge.*) Have you a form of certificate receivable with hops?—No, we have not.

3201. Do you require a certificate with hops?—No, we have never had any.

3202. Did you submit samples of hops to Dr. Miller?—I do not remember. I do not think we have ever had hops analysed.

3203. Then you did not send quite all the materials for analysis?—Apparently the hops we have not.*

(*Dr. Miller.*) I think you must have sent them at the beginning, but I have not had them lately.

(*Witness.*) I cannot answer that.

3204. (*Dr. Whitelegge.*) If any were sent the results were negative?—Yes.

3205. You told us the books you produce would show the source of the materials used in the manufacture of any particular beer?—Yes.

3206. So that afterwards you could trace any ingredient?—Yes.

3207. Would the returns you make to the Inland Revenue cover the same ground?—They would not be able to pick out the particular qualities of materials used, but they could pick out the quantity.

3208. They could not follow the ingredients of a particular brew?—You mean to say that, supposing we use Garton Hill's and Bostock's makes, they could not follow that?—No, they would not. How it was divided up they would not be able to tell. But, of course, we can trace it ourselves. Will you allow me to thank you on behalf of my directors for the courteous way you have treated me, and to say that we shall be very glad to give you further information if any is needed by the members of the Commission.

* Note by Witness.—The hops were analysed by Matthews and Lott and the local public analysts.

Dr. Alexander K. Miller, called; and Examined.

Dr. A. K. Miller.

3209. (*Chairman.*) You have been acting as consulting brewers' chemist for the large number of breweries in and around Manchester?—Yes.

3210. For many years past?—Yes.

Brewers' tests before epidemic not directed to arsenic or substances injurious to health.

3211. Before this period of November, when this epidemic took place, what was the system under which you tested beer or samples of beers from different brewers?—In the case of the samples they were all tested for their brewing value.

3212. And solely for trade purposes?—Yes.

3213. Then until November last you never tested any beer or material used for brewing except for the purposes of trade?—That is so.

3214. As to whether there was any substance in it that was injurious to trade, but without any consideration whatever as to whether there was any substance or material which would be injurious to human life?—That is so.

3215. It is only since this epidemic that you have examined beer or materials for the purpose of detecting whether they were infected with arsenic or not?—Yes.

3216. Will you tell the Commission under what standard you have been lately examining these various samples?—Recently the standard has been one set by the experts, Reinsch's test.

3217. By the Expert Committee?—Yes, appointed by the Manchester Brewers' Association.

3218. They framed this Committee when this disaster occurred?—Yes.

3219. It was formed for their protection in the future as well as to discover the causes of the catastrophe that had happened?—Yes, and the best way of eliminating arsenic.

Arsenic in non-Bostock beer.

3220. Have any of the beers you have tested since the disuse of Bostock's sugar failed to come up to the expert's standard of purity?—I should say that at the commencement, before the malts had been got anything like as pure as they are at the present time, there were occasionally beers which did not pass the test, but I think I should add that the test is undoubtedly far more delicate than is generally imagined.

3221. The test you are using to-day?—Yes.

3222. That being the test suggested by the Expert Committee?—Yes.

3223. (*Dr. Whitelegge.*) How delicate do you consider it to be?—I do not care to commit myself to any definite numbers, because I do not think any of the quantitative results which have come under my notice are absolutely reliable. I do not think there is any satisfactory quantitative method for determining accurately the minute quantities of arsenic which are present in these beers, so that I do not like to bind myself to any quantity. But I believe at the present time, if I may put it approximately, that the majority of the Manchester beers contain say 1-100th of a grain. I should say 1-50th of a grain is probably the maximum, and many of them contain nothing like 1-100th of a grain.

3224. The expert committee's test would not give a positive result for 1-50th?—I think it does.

3225. A positive result for 1-50th?—Yes.

3226. But not with a 1-100th?—The evidence I have in respect of that is this, that if I take a beer which gives absolutely nothing under the test, and if I then add to it 1-50th grain to the gallon the beer does not satisfactorily pass the test. Even when I add 1-100th of a grain to the same beer I get distinct indications of arsenic under the test.

3227. (*Chairman.*) You consider that a satisfactory test?—I consider it is much more severe than is generally imagined.

3228. (*Dr. Whitelegge.*) Does that suggest to you that the test improves with acquaintance, that skill plays a great part in it? That you would detect now by the same means a smaller quantity than you would have detected when you first used the test?—I dare say one does acquire a little extra skill. I have had about 4,000 samples passing through my hands, and it is possible one gets a little more skilled in it, but I do not think there is much in that.

3229. The previous witnesses have told us the test would distinguish 1-20th of a grain, and possibly 1-30th?—It depends entirely on how the standards are made. For instance, if I add 1-20th of a grain to water and carry the test through in the usual way I may get indications of arsenic, but the test is undoubtedly far more sensitive in beer than it is in water.

3230. Can you say why?—No, I cannot. I am experimenting at the present time. I have tried the test time after time with water with 1-20th of a grain per gallon, and I get practically nothing. In beer, taking

beer of the highest repute which gives nothing in the test, I can get indications of arsenic with 1-100th; with 1-50th, the beer does not necessarily pass the test, and the crystals are well marked.

3231. Do you attach importance to the size of the crystals in that connection?—The size in conjunction with the numbers undoubtedly.

3232. (*Sir William Church.*) In those cases in which you say the arsenic is indicated in beers when it would not be indicated in water, is it mere staining of the copper you go by?—No.

3233. Did you get arsenic crystals afterwards?—Yes. I say that the copper itself does not always become even discoloured with water.

3234. (*Chairman.*) I suppose it is very important, is it not, that there should be something like uniformity as regards the standard of tests applied?—That is so.

3235. It has come out lately, has it not, that samples of beer have passed a severe test, and then on a further test being applied the very same sample has shown traces of arsenic?—Any beer at the present time in this country would probably show traces of arsenic if the test is made severe enough.

3236. Do you think it is a question of degree, that there must be some arsenic in all the beers drunk, an infinitesimal quantity?—Yes.

3237. You have been testing these beers and substances ever since this catastrophe?—Yes.

3238. Can you state to the Commission what is your general idea as to the quality of the beer being drunk in Manchester or Salford at this moment. Should you say that although not absolutely pure from arsenic yet so far as any danger from poisoning was concerned it was sufficiently free?—Absolutely safe; and I should say the beer brewed in Manchester and Salford at the present time is as pure as any beer brewed in any brewing district in the country.

3239. Has arsenic been found especially in caramel?—No. I do not say it has not been found in any caramel, but taking caramels all round it has not been found in caramels more than in any other sugars.

3240. Have you been analysing malt for the purposes of discovering if any arsenic is contained in it?—Yes.

3241. Can you give the Commission the general result of your observations?—At the present time there is still some contaminated malt on the market, but the improvement as regards freedom from arsenic has been very marked. Many of the malts are practically free from arsenic, but there appears to be a difficulty even yet in producing absolute freedom; not universally, but in many cases. The malts, taking them all round, at the present time are practically free.

3242. As regards the test which you have been applying to find arsenic in malt, can you say at all over how large a district these samples spread? What I want to get at is: were these samples you have been testing given to you in Manchester, Salford, and the surrounding district, or from a larger district?—I have them from the brewers under numbers, so that I do not know where they come from. Then I have them from the maltsters throughout Yorkshire, Newark, Gainsborough and Nottingham.

3243. That is a considerable district?—Yes.

3244. Can you call to mind any district further south from which you have had specimens—Norfolk or Suffolk, Cambridgeshire, or the Southern Counties?—No, I cannot say I have.

3245. When you say that during the last 3 or 4 months, I presume you mean that period when there has been a great improvement in the quality of the malt?—Yes, during the last three months.

3246. Do you mean the Commission to infer from that that there has been rather an alarm spread owing to the information given as to the possibility of arsenic being in malt, and therefore malt has been looked more after and been much more cleansed?—It is not so much a question of cleaning and cleansing; that has not had anything like the effect that was hoped. It is chiefly the change in fuel that has brought about the improvement in the malt; in fact, it is almost entirely the change in fuel.

3247. Do you think the maltsters have discovered that danger may accrue from using a certain kind of coke?—Yes.

3248. And that that fact has prevented the use of that particular kind of fuel?—Yes.

3249. (*Dr. Whitelegge.*) What kind of fuel ought to be used?—Anthracite.

3250. (*Chairman.*) Are you of opinion that coke is dangerous for malting purposes, or only certain kinds of coke, and that some test should be applied to the coke?—I think some test should be applied to the coke. I do not think one can lay down anything definite as to one class of coke, such as oven coke, being absolutely safe, and gas coke being absolutely unsafe. I have had some samples of oven coke certainly worse contaminated with arsenic than some samples of gas coke I have had, and *vice-versâ*. Speaking generally oven coke is probably safer.

Malting fuels compared.

3251. You think the only danger of the contamination of malt with arsenic arises from the fumes of the coke?—Yes. The anthracite is liable to be contaminated to a small extent, and some maltsters of repute tell me that some of the malts which I have returned as containing distinct traces have been dried solely with anthracite.

Traces of arsenic in malt dried with anthracite.

3252. (*Sir William Church.*) I want particularly to ask you a little about what you were in the habit of doing before there was any suspicion of anything being wrong in the beer. You have told us that you then used to have samples of brewing material sent you by the brewers for testing, to see that they were unadulterated?—Yes.

3253. Did you have the samples of finished beer sent you?—Yes.

3254. For what purpose did you examine them?—To determine the stability of the beer was one of the chief points.

3255. To see how it would keep?—Yes.

3256. How did you judge of that?—We put it on what is called a forcing tray, a flat vessel containing water heated to 80° to 85° F. The samples of beer are placed in this warm place, and if they lack stability in a week or a fortnight's time one knows the beer will not keep. It will go sour.

Tests of beer before epidemic.

3257. Even when you tested the finished beers you did not test them chemically to see whether there were preservatives put in?—No. The brewer, of course, would know what he added himself. There was no object in our testing them for what the brewer had himself added.

3258. Your testing of the finished beers at that time then was solely for the advantage of the brewer, to see how long they kept? You did not examine why they kept?—No, we tested the composition of the beer as regards the amount of maltose present in the beer and its stability, but no tests were made in any way to look for poisons.

3259. Your examination of the finished beers was never intended, or supposed to be in any way carried on, for the safeguarding of the public?—No.

3260. It was for the interest of the brewers entirely?—Yes.

3261. You told Sir William Hart-Dyke you thought the expert tests you were using now were much more delicate than was generally supposed?—I believe so.

Application of Expert Committee's test.

3262. And you gave us very good reasons for thinking so?—Yes, and I have other reasons too.

3263. You said you took Burton beer?—Yes.

3264. Did you test that for arsenic before you added any arsenic?—Yes, I submitted it to the same test.

3265. And you found none?—I did not say I never found any, but in those particular samples, no.

3266. In those samples you added arsenic to, you found none?—I found none.

3267. And yet you said just afterwards you supposed there was no beer in England that would not show traces of arsenic?—There is a limit to the test. If the test had been made more severe. All I wished to do was to test the beer under the same conditions. If the test is made more severe I have no doubt you would find arsenic; in fact, I have found arsenic by the Reinsch test in the beer from the very same brewery. The samples vary.

3268. But not in the samples to which you added arsenic subsequently?—That was a sample which showed nothing under that particular test.

3269. You did not try to exclude arsenic altogether from that beer which you used?—I am afraid there is a difficulty about getting beer absolutely free, but it was free to the test.

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3270. You only used 200 cc. to begin with, I suppose?—Yes.

3271. You did not use a larger bulk?—No.

3272. Or concentrate it in any way?—No.

3273. Therefore it is only an assumption of yours that all beers contain traces of arsenic?—Of course I have not tested every beer, but I think it is a fair assumption to make.

Arsenic in malt.

3274. How do you think the arsenic gets into the beers?—From the malts.

3275. You think that all malt is sufficiently contaminated to give traces of arsenic in the finished beer?—I think that in the future it will be possible to obtain beers distinctly freer from arsenic than any of the beer hitherto.

3276. I do not mean in the future, but you think that in the past the presence of arsenic could be demonstrated in all beers owing to the contamination of malt?—Yes. I believe in the case of large breweries where they may have arsenic-free malts that part of their malts have been contaminated more or less. Probably no large brewery will have worked entirely with arsenic-free malts.

3277. Did you ever have malts submitted to you in previous years for the purpose of analysis?—Yes.

3278. For what purposes?—For their brewing qualities. The amount of moisture present, the amount of extract which they yield, and their diastatic capacity, etc.

3279. You never examined them for contamination?—Not for poisons.

3280. I suppose that same remark would apply to other brewing materials, glucose and sugar, submitted to you?—Yes.

3281. You only examined them to see that they were pure from the brewers' point of view?—Certainly.

3282. You also told us that since your attention had been directed to the subject of arsenic in malt you had found many malts free from arsenic?—Yes.

Testing malt for arsenic.

3283. I suppose you infused the malt in some way, and then made use of the test?—I applied the Reinsch test directly to the malt itself without mashing it in any way.

3284. By boiling the malt?—I just ground the malt and submitted it to the Reinsch test.

3285. It is only lately you have done that; you never tested malt in that way previous to this epidemic?—No.

3286. Therefore you can say nothing as to whether any were free previous to this?—No.

3287. How do you think these malts have been prepared which you find now free from arsenic?—Chiefly with anthracite.

3288. I think you said that you knew some malts which were wholly prepared by anthracite fuel where there was arsenic?—Yes, the anthracite varies, but is not seriously contaminated like many cokes.

3289. Among these malts you have examined lately, has there been a great difference in the amount of arsenic present in them?—A good deal of difference.

3290. Could you tell us at all where the worst samples come from?—Most of the samples I got merely from the brewers under numbers, so that I do not know where they come from.

Arsenic in fuels.

3291. You said you thought oven coke would probably contain less arsenic than gas coke. Have you ever made any analysis of cokes for that purpose?—I have tested them qualitatively. I have not determined the exact amounts.

3292. Did you say qualitatively or quantitatively?—Qualitatively. Comparative tests on weighed quantities, so as to get a fair comparison.

3293. You have not, of course, had the time to do that lately?—No, I have not.

3294. Your opinion is that the probability would be that oven coke would be safer?—Yes.

3295. Could you give the Commission any information with regard to the origin of the fuel used for making coke in different parts of the country?—No, I cannot.

3296. I presume the Grimsby coke would very likely be oven cokes, which are made in Newcastle and Durham?—I should think so.

3297. And Lincoln and Retford and Newark coke?—I have had contaminated cokes from Newark.

3298. Do you know sufficient of the malting trade to say what fuel is used in the Eastern Counties, Norfolk, and Suffolk and Cambridgeshire?—No, I cannot say, but I think a good deal of coke is used throughout.

3299. Yes, but we do not know where the gas coke used would come from, whether the London gas works or where?—No.

3300. Have you ever found contamination by arsenic in any of the other substances used in brewing, except in the glucose and sugar and malt?—You will find traces in the other substances.

3301. In what substances?—In some of the hops.

3302. In any others?—The malts and the sugar and the hops and the antiseptics are liable to contain traces.

3303. Which ones are those which are most apt?—The sulphites and the bi-sulphites. Of course the quantities used are very small.

3304. You do not think they have ever contained sufficient to be a source of danger?—No, I think not.

3305. Nor in any of the materials which I believe are sometimes used for clearing beer?—No, nothing more than minute traces.

3306. Different preparations of calcium are used largely?—Yes, bi-sulphites.

3307. (*Professor Thorpe.*) Do you wish us to believe that what is known as the experts' test is a sufficiently stringent test in the interest of public health?—I think so.

3308. Even although it is proved that the experts' test does allow a certain quantity of arsenic to slip through?—Yes, I think so.

3309. Would you recommend that that test should be laid down if necessary as a statutory test to be applied to beer?—I think the test might be modified.

3310. Modified in what direction?—I think that 100 cc. of beer with the boiling carried on for one hour instead of three-quarters the test would be improved slightly. It would be amply delicate enough.*

3311. Of course by halving the amount of beer you halve the amount of arsenic which is present?—Yes.

3312. You increase the duration of the boiling by 15 minutes?—Yes.

3313. You would not get under these circumstances a very much larger deposit of arsenic so as to make the certainty of catching it very much greater?—I think the certainty would be increased.

3314. When the amount you start with is only half?—I think that by carrying the boiling on for a further quarter of an hour——

3315. That is a very small percentage increase. I do not know that the addition of 15 minutes would make such a great difference in the amount of arsenic deposited on the copper?—What I wished to imply was that I thought the test before it is fixed as a standard should be submitted to further defined tests, and that was merely the direction in which I thought it might be done, but I did not wish to lay down any definite opinion on that point.

3316-7. Your opinion, so far as it goes, is rather in the direction of relaxing the test than increasing the stringency?—I may tell you that I think the test is a bit severe. It has been severe as a provisional test, and I think very severe, considering the circumstances. I do not think it can be too severe in the future in the least.

3318. I mean having regard to the possibility of a definite statutory test, or a test which has the legal value of a statutory test, being laid down?—In that case I should think the test does not want to be diminished in stringency.

3319. Have you formed any idea in your own mind why it is that it is easier to detect minimal qualities of arsenic in beer than in water?—No; it is only compara-

* Note by Witness.—In giving this answer I had in my mind some early experiments in which 200 c.c. beer was boiled down to 100 c.c., and the Reinsch test then applied to the latter. The quantity of beer tested was therefore 200 c.c., and not 100 c.c., and the test in this form is extremely sensitive.—A.K.M

tively recently that I have satisfied myself it is so. I cannot say why.

3320. Are you aware that Professor Delépine is of the same opinion?—No.

3321. It is entirely an independent opinion?—I have not heard a word from Professor Deléphine on the subject. I have known it for some little time. I was experimenting only yesterday, because I wanted to state it more positively than I was in a position to do before.

3322. Have you any reason to think that it may be the small quantity of alcohol which may be present which has an effect?—I do not think so, because the alcohol was boiled off in some of the experiments with beer before the copper was added and the Reinsch was still very sensitive.

3323. I suppose it is some influence which keeps the surface of the copper clean which allows the deposition of the arsenic upon it?—The copper comes out quite clean from the water experiments.

3324. There must be some influence of the solution on the copper to bring about the change?—Yes, unless the organic matter has some reducing action; but I do not know.

3325. Have you had occasion to test caramels?—Yes.

3326. Any number?—A good many.

3327. How are caramels usually made—from what material originally?—One, I believe, that I know of is made from glucose, but I think a good deal of them are made from cane-sugar. I do not know much about it. The process is kept secret.

3328. Have you any reason to believe that glucose which is off colour is sometimes used in the manufacture of caramel?—No.

3329. Do Bostock's make caramel or have they made it?—I do not think so. I came across one caramel which was seriously contaminated, but I was not able to trace it, so I have not said anything about it.

3330. Where did you come across that?—It came from a Liverpool firm. I asked for a further sample so that I might confirm it absolutely.

3331. A Liverpool seller or a Liverpool brewer?—A Liverpool seller.

3332. A manufacturer?—I got it from a brewer.

3333. Was the person from whom the brewer got it a manufacturer or an agent?—I believe he was an agent. They told me it was of German manufacture.

3334. The caramel was a German manufacture?—Yes, this particular sample.

3335. Was this very largely contaminated?—Yes, very largely contaminated.

3336. More so than Bostock's invert?—I should think to about the same extent. At any rate it was very seriously contaminated.

3337. Have you examined a good number of these glucose and inverts?—Yes.

3338. Other than Bostock's?—Yes.

3339. Have you found any to contain arsenic?—No.

3340. Only Bostock's?—Yes.

3341. Have you examined any foreign glucose?—Yes, one which contained distinct traces, but nothing like Bostock's.

3342. Bostock's invert and Bostock's glucose are the only brewing sugars in which you have found any sensible quantities of arsenic?—Yes.

3343. You told us that in your opinion the improvement, as regards freedom from contamination with arsenic, in malt was largely due to the substitution of anthracite for coke?—Yes.

3344. Could you go so far as to say it must be obligatory on the maltster to use anthracite?—It is difficult to say, because one maltster tells me that he can get arsenic free malts with the use of coke. I should not like to say it should be compulsory until the matter has been further investigated.

3345. You indicated a preference for the use of oven coke of the two cokes?—I think so. Generally speaking, it is preferable, but some of them are badly contaminated.

3346. What are oven cokes mainly used for?—I do not know, beyond maltings.

3347. Are they used by iron masters?—I do not know.

3348. Is there any particular kind of coal used for coking in an oven?—I do not know. I have never known much about these cokes; that which I know is entirely of recent acquisition.

3349. You are not aware, for example, whether persons coking coal in an oven would prefer to have their coal more free from sulphur than the gas manufacturer, for example?—I do not know.

Test for arsenic in malt.

3350. You spoke of testing malt. You gave Sir William Church to understand that you did that by what is practically the expert test?—Yes.

3351. You made an infusion of malt?—No. I made no infusion. I put it through the mill to grind it and boiled it with water, acid, and copper.

3352. Boil the whole thing together?—Yes. I tried mashing it, but I did not get such good results; if the malt is mashed first the test is nothing like as severe, and the brewers have asked me to test their materials as severely as possible.

3353. Would you be using an amount of material more than equivalent to the 200 cc. of beer?—Yes.

3354. In the case of the malts your test would be more stringent than in the case of the beer?—Yes, considerably more.

3355. I suppose you are frequently in breweries in Manchester?—Yes.

3356. Has your attention been drawn to any peculiarity in the yeasts of late years in the breweries?—No.

Selenium not looked for.

3357. Have you had the opportunity of looking for selenium in any of the materials that have come under your notice?—No. I cannot say I have.

3358. Have you tested for selenium?—No. I have only tested one or two beers the brewers have sent me to be tested.

3359. What happened in the case of the beers?—I could not find any.

3360. Whose beers were sent to you?—This was a brewer in Blackburn. He simply sent the beer because he had heard that there was an attempt at a "selenium scare," and he was somewhat alarmed, and asked me to test the beer.

3361. Had he been using Bostock's material?—This was only comparatively recently—a long time after Bostock's materials had been off the market.

3362. Have you examined any sulphuric acid which has been used in the manufacture of these inverts or glucose?—No.

Question of combination of arsenic with organic matter of beer.

3363. Have you considered at all in what form the arsenic is in beer?—No. I have thought about it, but I did not see how to arrive at a conclusion at all.

3364. You have no supposition in your own mind as to the form in which the arsenic exists in beer, whether as arsenious acid or the combination of arsenic as some organic compound?—No. I do not see why there should be any organic compound. Arsenic is probably present as arsenious acid in the malt, and I should think it would go in the same form into the beer.

3365. In what form is it in the invert or glucose, arsenious acid?—I think so.

3366. Does anything occur to you whereby in the process of fermentation any arsenical compound could be produced?—No.

3367. Anything in the nature of cacodylic acid or anything of that kind?—I do not know.

3368. Have you examined any yeasts for arsenic?—Plenty.

Affinity of yeast for arsenic.

3369. Have you found it?—Yes. Yeast has a remarkable power of accumulating arsenic in it.

3370. Do you mean there is some specific action on the part of the yeast organism to take out arsenic?—Yes.

3371. You think arsenic is practically a sort of food for the yeast?—Or else the arsenic gets in and cannot get out again.

3372. Is it anything connected with the metabolism of yeast, or is it a mere mechanical action?—I cannot say, but I know that the yeast contains far more than the beer.

3373. Does it occur sporadically; is there any relation between the amount of arsenic in the yeast and the amount of arsenic in the original materials?—I cannot say that there is.

3374. Do you sometimes find much arsenic, and some-

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times little arsenic on the yeasts?—No. Before the malts were really pure, as they are now comparatively speaking, the yeasts were badly contaminated. Now the yeasts are only slightly contaminated. In some cases they come out quite pure under the same tests.

3375. Have such samples of hops as have been submitted to you contained much sulphur?—I have not tested for sulphur, but only for arsenic.

3376. It is not conceivable in your mind that the arsenic on the yeast may have been mechanically thrown down by the action of sulphuretted hops upon a solution of arsenious acid?—It never occurred to me.

3377. Is that a likely surmise, do you think?—I should not think it was impossible.

3378. Supposing you were to boil hops dusted over with sulphur, or containing sulphur, with a solution of arsenious acid, as you would, of course, might not that lead to the greater precipitation of arsenious sulphide?—I should think it would.

3379. And the yeast would tend to pick it up or mechanically entangle it?—Yes.

3380. (*Dr. Whitelegge.*) You were going to give us some additional reasons for considering the expert committee's test a very delicate one?—Yes. I know for a fact that certain beers which I have tested have been tested also by the Marsh test by a chemist of repute, not in one case but in three or four cases. Where I have told the brewer that his beer was near the limit permitted by the test, but not outside it, the quantity of arsenic present has been reported to him by the other analyst in one case as 1-200th of a grain, and in another 1-300th of a grain. That was done by a chemist of repute, who is certainly able to carry out the Marsh test in a satisfactory form.

Arsenic in malt.

3381. What is the largest amount of arsenic you have found in malt?—I have not made any exact quantitative experiments. I should think up to 1-20th or 1-30th of a grain, certainly, to the pound.

3382. Have you condemned malts for arsenic found in them?—Yes.

3383. Do you condemn them if you find any arsenic at all?—No. I leave it to the brewer to use his own discretion when the trace is small.

3384. You report the amount to him?—I carry out the test in a severer form than in the case of the beers; then if I get distinct crystals which I should not pass in the case of the beer I advise the brewer to get a purer malt, because a malt giving a sublimate which in the case of the beer would not be regarded as satisfactory, cannot be considered satisfactory. It is merely a comparison. I have the expert's test as a guide, and I make the test severer in the case of the malts, because the brewers have asked for it.

3385. You mean you make it more severe having regard to the amount of malt that goes into beer?—Yes.

3386. You take an amount of malt which is comparable to the 200 cc. of beer?—Yes. I take an excess of the malt over that.

3387. In those which you condemn you say there is arsenic present?—Yes.

in hops.

3388. And they ought not to be used?—Yes.

3389. The last witness told us he was not in the habit of sending samples of the hops for analysis, but I gather from you other brewers do?—Yes, some.

3390. Have you had occasion to condemn any hops containing arsenic?—No, but I have advised the brewer when arsenic is present to give his hop merchant a caution, because there is no doubt that hops can be obtained easily free from arsenic.

3391. Perfectly free?—I should say so.

3392. Can you tell us how much arsenic you found in the sample of glucose said to be German?—No; it was only a trace.

in caramel.

3393. Can you tell us the amount in the caramel sample?—No. I only had the one small sample I have already spoken of, and I condemned it at once. I wrote for further samples, but it was too late. They had returned it all.

3394. (*Sir William Church.*) I should like to know what you mean by the term in your certificate "pure" with regard to malt?—I mean that under this test I can find no arsenic in it.

3395. (*Chairman.*) In each case?—Yes.

3396. (*Sir William Church.*) Under the experts' test?—Yes. It is a modification of the experts' test.

3397. (*Chairman.*) You use a distinct expression with regard to the malt to what you use with regard to the finished article. You say with regard to beer "It readily passes the expert test." What Sir William Church wishes to know is why you use the term "readily passes the expert test" as regards the beer, and a different term with regard to malt. You say "M56 is pure"?—The experts merely laid down the test as regards the beers. They have given me no instructions whatever as regards materials. That is left to my judgment, and at the request of the brewers I have applied a severer test to the materials, and if I get no arsenic under that test I report them as pure.

3398. (*Sir William Church.*) "Pure" means absolute freedom from arsenic, not that there is a trace of arsenic in it?—It means there is absolute freedom as indicated by that test. That this test applied in a severe way to the material shows nothing.

3399. (*Professor Thorpe.*) In fact you mean, if I am able to read your mind accurately, that inasmuch as in the case of the malts you have condemned a proportionally larger quantity of potential beer you think it has been therefore more stringently applied?—Yes.

3400. (*Sir William Church.*) But "pure" means that it did not re-act to that test?—Yes.

Beer Expe mitte condu by P. lyst.

3401. (*Chairman.*) Are you aware that any beers which have passed your test have been pronounced arsenical by a public analyst or any other chemist?—Yes. I may say that in the case of one brewery where they have never had Bostock's sugar at all, in a certain town not far from Manchester, they got a threatening letter from the authorities saying their beer contained 1-250 of a grain per gallon; that they were not going to prosecute on that occasion, but that it was not to occur again. There is another case of a brewery whose beers are at the present time really practically pure. They will not touch any malts which I have not passed as pure, and their beer certainly contained nothing like 1-100th of a grain. In their case they have a prosecution coming on, I believe. The public analyst reported the beer contained a trace too small for him to estimate. On the strength of that certificate I believe the authorities are going to prosecute, but in my opinion the beer is absolutely safe.

3402. (*Sir William Church.*) Have you any idea of the amount of arsenic that can safely be present?—No, I think it is a question for the medical men.

3403. But you just now expressed an opinion. You said you were quite sure you passed no beers that were not absolutely safe?—I do not think I said that. I said, in the case of this particular brewery, where I know their malts have been all tested by myself and found to be free, I am perfectly satisfied that in that particular case the beer must be absolutely safe, because their materials have all passed through my hands, and I know the degree of purity, and at the present time they cannot obtain purer malts than they have been obtaining.

3404. That only comes to this, that you would not be prepared to express an opinion to the Commission whether any beer is safe?—Whether any beer is absolutely free; I should not like to say that.

3405. You have not formed any opinion as to what amount is harmless?—Certainly not.

3406. (*Chairman.*) But you have spent many months in going into these matters very thoroughly and testing, not only beer, but all materials used in beer. You have studied the marked change there is as regards purity of material, especially as regards malt, and you are satisfied that with a little common care beer brewed from malts and hops can be absolutely secure as regards the consumer?—Certainly.

3407. (*Dr. Whitelegge.*) Have you examined any beers for arsenic of a date prior to the trouble with Bostock?—Yes, you mean recently?

Arsen non-l beer epide

3408. Yes. With what results?—Two or three weeks ago I had a batch of beers sent to me from one of the local breweries. They generally send me all their brews—about a dozen at a time. I received about a dozen, and these came out so different from usual that I did not know what to make of them, and I sent a report saying that none of the beers passed the test. I expected to hear from them next day, but as I heard nothing, I went and saw the brewer, and asked "What

are you doing" He took me into the office and showed me the actual bottles from which the samples were taken, and told me the explanation was this. These were beers which were purchased from different public-houses last November; I was shown the list of the breweries supplying them, and some of these were certainly breweries where no Bostock sugar had been used. In spite of that, not a single beer passed the test as I am now applying it.

3409. Can you give us an idea of the quantity of arsenic?—I should not like to say. They were tested by the same test. It satisfied me and satisfied them that even the contamination of the malt at that time was very different from what it is now.

3410. Were they local brewers?—Yes.

3411. All of them?—I believe so.

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3412. (*Professor Thorpe.*) Do you mean us to believe that seriously arsenicated beer was in use prior to the trouble of which we have heard?—These were all taken in November.

3413. When were they brewed?—Probably they were brewed within a few weeks of that time. What I mean is that in some cases they would be from breweries where no Bostock's sugar had been used. Of course, I reported some of those which were worse contaminated than others. I should have had no difficulty if I had been asked which were Bostock's and which not in discriminating between the two. But even those not brewed with Bostock's sugar would not pass the test as it is now being carried out, and this is further evidence that the test is not a light one.

Mr. Harold B. Dixon, called; and Examined.

3414. (*Chairman.*) You are Professor of Chemistry at Owens College, and a Fellow of the Royal Society?—Yes.

3415. Can you give the Commission some information as to the presence of arsenic in sulphuric acid?—Yes. Whenever the sulphuric acid is made from pyrites—and, indeed, when it is made from brimstone, it may contain a little—but when made from pyrites it generally contains a good deal, especially nowadays, when it is made most largely from Spanish pyrites.

3416. A large percentage of pyrites comes from two sources, but is chiefly Spanish?—The most important ores are from Spain, the Rio Tinto and the Tharsis mines. The next largest quantity is from Portugal, an extension of the same mines, and practically the same material.

3417. In the case of sulphuric acid that is used in connection with beer or food, do not you think some very safe process should be gone through to eliminate the arsenic?—Obviously.

3418. I think the Commission would like you to describe the means by which this can be done. Or perhaps it would be better for you to go into the manufacture of sulphuric acid, and then deal with the purification afterwards?—The pyrites are chiefly used on account of their cheapness. They contain 3 per cent., or a little more, of copper, and the sulphuric acid manufacturers really purify the pyrites so that they can be used for the extraction of copper afterwards. It is for this reason that these particular pyrites have superseded other sources of sulphur. The pyrites are broken up and burnt in kilns, and the sulphur from the sulphide of iron burns off as sulphurous oxide and passes through flues, generally through what is called a Glover tower, and then into large leaden chambers where the chamber acid is made. If there is arsenic in it, and there is always some arsenic in the Spanish pyrites, the arsenic mainly burns off as arsenious acid, and this is partly caught in the flues and partly in the Glover tower, down which a strong acid is falling, so that the gases are washed on their way to the chamber. In the washing and in the previous cooling and dust chambers most of the arsenic gets caught. The remainder passes on into the chambers where chamber acid is made. Therefore, in considering sulphuric acids we have to distinguish sharply between Tower acid, the acid which falls down the Glover tower, and contains a considerable quantity of arsenic, and the chamber acid, which is made further on, which contains always less arsenic. The chamber acid which is made in the large leaden chambers is generally evaporated down to make it stronger, and where the Spanish pyrites are used they are largely purified from arsenic by several processes. You will probably get more exact information from manufacturers, but it is not very easy to get evidence on this point; I know in this district that hydrogen sulphide is largely used as a means of purification. The contact of hydrogen sulphide with the arsenicated acid produces sulphide of arsenic, and this forms gradually a yellow precipitate which settles largely, and the rest is filtered off. The purified acid is then boiled down until we get either the ordinary acid, called B.O.V., when it is evaporated down in leaden pans to a density of 1·7, or rectified acid when it is boiled down more thoroughly in glass or platinum vessels.

3419. Do you know if it is the practice at these works where sulphuric acid is made to test each lot of acid as it is made for the presence of arsenic?—I do not know.

3420. Do you happen to know what tests are applied in these works?—I know where they are purifying from arsenic they apply hydrogen sulphide afterwards to see if the arsenic has been precipitated.

Mr. H. B. Dixon.

3421. If you get sulphuric acid in your laboratory, do you find arsenic in it?—Nearly always.

3422. If you get what is called the finest sulphuric acid?—It is rather a chance whether it contains a trace or not. It is very difficult to get it quite pure. Even when you buy it as quite pure, it sometimes contains a trace.

Difficult to get sulphuric acid quite free from arsenic.

3423. (*Professor Thorpe.*) You have had some of this Nicholson's acid through your hands, have you not?—Yes.

3424. How did you become possessed of it?—Dr. Tattersall brought it to me.

3425. From where?—I believe from Bostock's.

3426. What type of acid was it?—I should imagine it was tower acid.

3427. What was the colour of it?—It was a dark brown, with a precipitate in it.

3428. What was the colour of the precipitate?—Brownish.

3429. Did you recognise it as brown oil of vitriol?—I should have considered it a tower acid. Brown oil of vitriol is rather a common name given now to that which is brown as well as to that which is not brown. You will find the name B.O.V. is given to an acid which has not any brown colour at all. The name is a survival.

Appearance of Nicholson acid.

3430. Does not brown oil of vitriol denote acid of a particular strength?—Yes, from about 1·7 to 1·75.

3431. Was this acid of that type?—Yes.

3432. It was not rectified oil of vitriol, or so-called double oil of vitriol?—No.

3433. Did you analyse that acid for arsenic?—Yes.

3434. What amount did you find?—1·44 per cent. by weight of arsenious acid.

Amount of arsenic therein.

3435. How did you determine that amount?—I weighed it as sulphide of arsenic.

3436. How did you get it out?—I used Hattensauer's method. I diluted the acid to about 1·55 with pure water, and then added an equal volume of pure hydrochloric acid. I then precipitated it by passing hydrogen sulphide through it for about five hours, testing the acid when it was clear to see if any more fell. Then the arsenic sulphide was collected and dried, then weighed, and then tested to see whether it was completely volatile and soluble in ammonia. It was both. I then heated it in a tube in a current of carbonic acid, and the residue was weighed again. I took the residue to be $As_2 S_3$.

3437. Did you examine the precipitate when you got it out of the acid?—It went into solution mainly when I added the water. There was very little to filter. I did filter it, but it was very little.

3438. What do you think it was?—I imagine some arsenious acid was there, and a little suspended oxide of iron.

3439. Was the sulphuric acid practically a saturated solution of arsenious oxide?—I should think very nearly.

3440. Have any determinations been made as to the amount of arsenious oxide which sulphuricacid would

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take up?—Not very accurate ones. It depends upon the strength of the acid. I do not know of any accurate determinations.

3441. Do you know of any other determinations which have been made of the amount of arsenic in Nicholson's acids by different people?—Only by hearsay and newspaper reports.

3442. Is it known as to whether considerable quantities of this saturated solution of arsenious oxide have been delivered by Nicholson's to Bostock's?—I have heard that Professor Campbell Brown, of Liverpool, tested this acid from Bostock's, and found, I think, nearly 2 per cent. of arsenious acid in the sulphuric acid. I have heard of another analysis going as high as 1·8.

3443. In those cases was there also a sediment?—I believe so, and I believe the sediment was reckoned as well.

3444. Did that sediment contain arsenious oxide?—I believe so; but I dissolved my sediment before precipitating.

Selenium.

3445. Have you examined that sulphuric acid for selenium?—I did not examine Bostock's acid for selenium, but I have examined another acid made in practically the same way from Rio Tinto ore for selenium, and I have examined the flue dust in a large works where Rio Tinto ore has been used.

3446. Was there much selenium?—None that I could detect.

3447. Was there any in the dust?—No, nothing appreciable.

3448. You know that to be the same source of ore as Nicholson's?—No; I think Nicholson is using Tharsis, but it is very similar. One ought to detect it if present in the flue dust. It is quite easy to detect selenium in flue dust when seleniferous ore has been used.

3449. When selenium dissolves in oil of vitriol, does it give it any particular colour?—Yes; it goes green.

3450. Therefore, when it is present it attracts attention at once?—Generally.

Proportion of arsenic in Nicholson's acid extremely high

3451. (*Dr. Whitelegge.*) Does not tower acid contain a great deal more arsenic than chamber acid?—Yes, usually.

3452. In the example you give in the *précis* the tower acid contained ·735 per cent., and the chamber acid ·139?—Yes.

3453. In the sample of Bostock's you told us you found 1·44. May we take it that that is an excessive amount of arsenic to find in sulphuric acid?—I think it is. I have not found so much myself anywhere else.

3454. Can you tell us what would be an ordinary amount to find?—I think anything up to 1 per cent.

3455. (*Professor Thorpe.*) How do you surmise so large a quantity of arsenious oxide could have got into this acid? What condition of manufacture could have led to so large a quantity being there?—I can only imagine that the flues contained a large quantity, or the dust chamber. I have not been over Nicholson's works, and do not know whether they have a flue or not, but probably they have some form of dust chamber, and perhaps some of this material was carried over into the tower. I imagine this acid must have been tower acid.

3456. Obviously it must have been going on for some weeks or even months, apparently, the saturation of this sulphuric acid with arsenic?—Yes.

3457. What condition of manufacture occurs to you which would induce it?—The flue dust very often contains 40 to 50 per cent. of arsenious acid, and if a considerable quantity of this got carried over and fixed in the Glover tower the acid running down the tower would be nearly saturated, because it comes out hot, and hot acid dissolves more arsenic than cold acid.

3458. Does a vitriol maker ever clean out his flues?—Yes.

3459. Do you imagine it was neglect on the part of Nicholson's to clean out their flues which led to this?—I cannot say.

3460. (*Chairman.*) Have you any other suggestion to give as to the presence of that abnormal quantity?—No. I have found arsenic to vary rather considerably. This 1·44 happens to be the largest I have personally found in sulphuric acid, although I have not examined any large number.

3461. (*Professor Thorpe.*) Is Tharsis ore or Rio Tinto ore known to contain a large quantity of double sulphide and arsenide of iron. Does the arsenic run up and down?—Different parts of the ore contain different quantities. There are pockets of this ore in which sometimes the copper is very much richer than in other parts, and I think the same thing applies with regard to arsenic. I know you must take a very considerable quantity of the ore to get an average sample, and therefore any particular sample used in the kilns may contain more arsenic than at another time. Some of it, I believe, is free and some contains a considerable quantity. It is usual in making an analysis to sample some three months' working, 2,000 or 3,000 tons at a time.

3462. When an analysis is made of the ore, to what extent is the analysis carried?—When the sulphuric acid makers buy it they only determine the sulphur, I believe, because that is the only thing they are going to make use of it for.

3463. Do they take no notice of the other things?—No; they do not even determine the copper. They guarantee that the copper goes back.

3464. The sellers of the ore take back the spent oxide?—Yes.

3465. (*Chairman.*) Arsenic is not spread over the whole material as an average, but if there is a large amount of material taken, a large quantity may be found in a small portion of it?—I believe that is so. I have not any direct experience of that, but looking at the analyses published of Rio Tinto ore one can see that some of the analyses were as high as 2 per cent. of arsenic, and yet the average is perhaps only ·5. The sample I examined lately was from 2,000 tons of ore worked for three months, April, May, and June, last year. I had a sample of which the sulphur had been determined, and I determined the arsenic, and I found ·53 per cent. of metallic arsenic, a larger percentage in that than was the average in 1886, viz., ·33 per cent.

Selen... in Norw... Pyrit...

3466. (*Professor Thorpe.*) Selenium is generally met with in the Norwegian product, is it not?—Yes, and the Hartz pyrites, but in the Norwegian most. I have samples of dust from Norwegian works containing plenty of selenium.

3467. Is Norwegian pyrites used much in this country?—It has been all superseded, I believe. I do not think any is imported.

3468. (*Sir William Church.*) With regard to the flue dust, supposing that the flues and the dust chambers are insufficiently attended to, would that cause the Glover tower to be a source of arsenic rather than a means of straining it off from the acid?—Yes, that might be so.

3469. And do you think that might occur and might not improbably be the source?—It is always liable to occur, I think.

3470. I suppose in the same way, not sufficiently changing the materials in the Glover tower would lead to a highly impregnated sulphuric acid?—I do not think they are often cleaned out.

3471. (*Dr. Whitelegge.*) Do you think if sulphuric acid is intended for use for food purposes it is safe first to trust to the manufacture of arsenical acid and then to its purification?—I think it wants careful testing. I think an acid can be purified, and you can get an acid as free from arsenic as you can get the acid from Sicilian sulphur. Sicilian sulphur does sometimes contain a little arsenic.

Const... care ... to ob... arsen... acid

3472. But you think if it is made from an arsenical pyrites it is necessary to exercise constant care and supervision?—Certainly. It is, I think, easy to allow some arsenic to go forward when one of these methods of purification is used. I think it wants constant care.

3473. And such an accident must occur now and then if there is not sufficient care?—It is always liable to occur.

3474. Can you tell me how much arsenic you find in what is sold as the finest form? You told us that sometimes you found very little and sometimes a great deal?—In that which is sold as the purest brimstone acid sometimes one finds none at all and sometimes one finds a trace. It is not in a weighable quantity. In order to determine the amount one would have to make a comparative experiment.

Acid ... brims...

3475. (*Sir William Church.*) Do you think that what is called brimstone acid could be used without being actually tested to see whether it is free from arsenic?—It depends rather on the sulphur that is used, because the name brimstone is given not only to the nearly pure

Sicilian sulphur, but also to recovered sulphur obtained from calcium sulphide, the alkali makers' waste, which often has a great deal of arsenic in it, and unless the method by which the sulphur is recovered is a good one and carefully watched you may have arsenic.

3476. Do you think if it is made compulsory that sulphuric acid used in the preparation of food products should be made from sulphur, that would be reckoned enough without examining to see whether it was free from arsenic?—I do not think it would, because I think a sulphur might be got which contains a lot of arsenic. Some Japanese sulphurs contain a good deal. It happens that Sicilian sulphur contains very little, but it does contain some here and there. If you merely say sulphur, there are sulphur mines in many parts of the world, and there would be no security either that the natural sulphur, or the sulphur recovered from some manufacturing process, was free from arsenic.

3477. It would not be a sufficient safeguard then?—Not nearly. The purest sulphur I know of is that got from coal gas works, the spent oxide sulphur. That contains none.

3478. (*Chairman.*) You have never discovered any in that?—No, and that is used in this district for making brimstone acid.

3479. (*Dr. Whitelegge.*) Can you tell us of any organic compound of arsenic that would tend to throw light on the recent difficulty?—I am not a professor of organic chemistry and could not answer that question. It is possible, but I do not think it is likely.

3480. (*Chairman.*) I think you have brought us some specimens of flue dust and other materials to show us?—Yes. (*Specimens shown to Commission.*)

Dr. T. N. Kelynack, called; and Examined

3481. (*Chairman.*) You are Hon. Medical Officer to the Pendleton Branch of the Salford Royal Hospital?—I am.

3482. And Medical Registrar to the Manchester Royal Infirmary?—Yes.

3483. Assistant to the Professor of Medicine at Owens College, and Lecturer on Food and Food Inspection at the Manchester Technical School?—Yes.

3484. You have some important evidence to give us with regard to the history of the epidemic of arsenical poisoning, which you have been personally investigating?—Yes. On returning from my summer holidays in September, 1900, I noticed that a large number of alcoholic cases were attending my out-patient department at Pendleton. During the autumn these increased in number, and many presented exceptional features. At the beginning of November Dr. J. W. Crawshaw, of Weaste, called on me, and described what was thought to be an anomalous case of Addison's disease then under his care. On the 12th I saw the patient with him. The symptoms were those of chronic arsenical poisoning. During November a marked increase in the number of cases of peripheral neuritis in the Manchester Royal Infirmary was noticed, and the cause discussed. On attention being directed to arsenic as the probable explanation, I arranged on November 20th with my colleague, Mr. Kirkby, Lecturer on Pharmacognosy, in The Owens College, and Dr. Forsyth and Dr. Harold Bailey for an investigation of the matter. Mr. J. G. Groves, M.P., of the brewing firm of Messrs. Groves and Whitnall, afforded us every facility for our work through Dr. Forsyth, medical officer to the workmen engaged in the brewery. The presence of arsenic in the beer was at once detected, and the source speedily traced. On Friday morning, November 23rd, as Mr. Groves has already told the Commission, I called at the Salford Brewery, and informed him that Mr. Kirkby had discovered the presence of arsenic in the invert sugar, and its further use was, I believe, immediately stopped. I also communicated with the Medical Officers of Health for Manchester and Salford, and Professor Julius Dreschfeld, Senior Physician to the Manchester Royal Infirmary was also informed. Our investigation throughout was designed and conducted purely on scientific lines and solely in the interests of the public health. During the latter part of November, and the beginning of December, through the courtesy of the Medical Officers of Health for Heywood, Bacup, and Blackburn, I was enabled to examine patients in those towns, and compare them with our Manchester and Salford cases. I also saw many sufferers in the Workhouse hospitals at Liverpool and Withington, and a number with private practitioners. Being urged to publish our results, Mr. Kirkby and I issued early in the present year our book on "Arsenical Poisoning in Beer Drinkers," which forms the basis of my evidence. A study of the outbreak shows that it is possible to make a rough division into more or less definite stages: (*a*) The onset, when the symptoms were chiefly those of irritation of skin and mucous membranes; (*b*) second stage, when more or less distinct multiple neuritis was present; (*c*) the stage of decline. The invasion of different districts has not been simultaneous. The gradation in the development of the outbreak helps to explain the delay in the recognition of the true cause of the epidemic. In the early stages the condition was confused with such affections as influenza, gastro-enteritis, conjunctivitis, Addison's disease, and various skin lesions. When neuritic symptoms became marked they were not unnaturally first thought to be dependent solely on the alcohol. There have been considerable local variations in the time of onset, severity, and duration. In Heywood, at the end of November, I saw cases which dated their first symptoms as far back as Easter, 1900. Dr. Hitchon, the M.O.H., informed me that the cases occurred in epidemic form immediately after the Whitsuntide holidays. In one rural district in which I saw cases, and where the beer contained as much arsenic as 1.4 gr. per gallon, the brewer early recognised the pernicious character of his brew, and on November 7th had it submitted to an analysis, and ultimately arsenic was found in it on November 17th. Although anomalous cases of peripheral neuritis and muco-cutaneous affection were occurring in Manchester and Salford in the spring of 1900 the outbreak, as judged from our hospital experience, did not assume serious proportions until October. A large number of cases dated their symptoms back to September. This is in part explained, I think, by the fact already indicated by Mr. Groves in his evidence, that, as regards his brewery, which supplies a large number of houses in Manchester and district, the arsenicated sugars were not used until August. During the three months, November, 1900—January, 1901, 41 well-marked cases were under observation in the Manchester Royal Infirmary. These I have tabulated as follows:—

Age and sex distribution

Cases of Arsenical Neuritis under Treatment in the Manchester Royal Infirmary during Nov., Dec. 1900, and Jan. 1901.

—	Under 30.	30.	40.	50.	60.	All ages.	Average age.
Males	–	7	12	4	1	24	43
Females	1	7	11	–	–	19	39
Total	1	14	23	4	1	43	41

The poor have suffered most severely. Both men and women have been affected. Some of the severest cases, and the majority of the fatal cases, have occurred in women. The average age of our recent infirmary cases has been 41 years, the average age of the women being 39. I am convinced that the published statistics give a very inadequate expression of the facts. Not unnaturally a great reticence has been apparent amongst many of the affected cases, and this reluctance to seek advice I have observed amongst the very poor. Considering the immense number of drinkers of beer known to have been arsenical it is surprising that more did not suffer. This shows that generally speaking there was not an excessive number of individuals exhibiting an idiosyncrasy to arsenic, but the influences of tolerance and idiosyncrasy in the individual must not be overlooked. I have met with no evidence of arsenical poisoning in any persons restricting themselves to spirits. Judging from what has generally been taught it seems a very remarkable fact that even confirmed drinkers in this district, who have restricted them-

Arsenical symptoms not met with in spirit drinkers

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selves to spirit, rarely present symptoms of peripheral neuritis.

3485. Would you wish the Commission to understand there was no doubt whatever in your mind as to the cause of this outbreak that occurred here?—No doubt whatever. We have proved that the arsenic was in the beer which the affected cases were obtaining from their public houses. We then traced that beer to the brewery, and we are able to find the arsenic in that beer. We also found the arsenic in the excretions from the affected patients, so that we consider all the links in our evidence are complete.

3486. As the completion of the link, were you able to refer the cases to beer which was brewed from Bostock sugars?—We were informed by the brewers that they obtained their sugar from that source, and the sugars that were provided for our investigation were said to have come from Bostock's, and in no case have we been able to trace the sugars to any other source.

More cases occurred than were reported

3487. You speak of the reluctance of patients in giving information. Do you mean as regards how much beer they drank, or as regards the symptoms from which they were suffering?—In many cases, even when very poor, the patients did not come to my out-patient department until late in the development of the disease, and long after the cause was popularly known. Apparently amongst the women there was a reticence in letting it be known that they were going to the out-patient department affected with this complaint.

3488. Do you think there was a reluctance on the part of the patients because it might be suspected that they had been drinking a great quantity of beer, and that that might be laid to their charge?—That was their idea I think, in the case of the women especially.

3489. Are you disposed to infer from that that even the number of cases which has come under your cognisance and the cognisance of others in this district might have been increased if there had not been that reluctance—that there have been cases where patients have been suffering from the poisoning and you have heard nothing of them?—Yes. We also know from patients, who stated that friends in their district were affected in like manner; and also I am acquainted with private cases which, as far as I know, have not come within the reach of any statistical return.

3490. You have published the results of all your experience in a book, have not you?—We published the results of our early experience. Since January, of course, we have been accumulating further evidence.

3491. You state here that when neuritic symptoms became marked they were not unnaturally at first thought to be dependent solely on the alcohol?—We had long been acquainted with so-called alcoholic peripheral neuritis in this district, and therefore when these cases first presented themselves with neuritic symptoms, the majority of men not unnaturally thought that it was an increase of the condition which had been long known to us.

3492. Are you aware whether these cases of peripheral neuritis have been more frequent in this district of Manchester and the surrounding district than any other parts of England?—I gather that that is the case, and I have placed that before the Commission in numbers which I have gathered, and which will be found at the end of my statement, which I will refer to a little later on.

Addison's disease

3493. (*Sir William Church.*) I should like to ask you a few questions about your experience before the last few months. You stated that what first attracted your attention was Dr. Crawshaw asking you to see an anomalous case of Addison's disease under his care. Do you know whether Addison's disease has been frequent in this district, or what has been supposed to be Addison's disease?—With a view to getting accurate statistics on that point I have looked up the pathological records, for I understand that a number of deaths have been registered in this district as due to Addison's disease during the past year; and therefore to ascertain its customary frequency in Manchester I have examined the pathological records, and of 1,478 medical cases investigated at the infirmary during the period I held the post of pathologist I found only three undoubted cases, or 0·2 per cent.

3494. How many years was it that you held that post?—Eight and a half years, from 1891.

3495. And in eight years there were only three cases registered as cases of Addison's disease?—There were only three cases met with in the post-mortem room.

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3496. And of those which did not come to the post-mortem room can you say anything?—I cannot say.

3497. There was nothing in your experience which makes you think that Addison's disease was supposed to be more frequent in this district than in other parts of England?—Certainly not; if anything I should rather think it was rarer. One of these cases occurred in 1893, the other in 1895, and the last case I made the post-mortem examination on was in 1897.

3498. What was it that suggested arsenical poisoning as the explanation to the officers of the Royal Infirmary?—The number of cases in the infirmary of peripheral neuritis had been occurring in greater frequency than was customary, and as registrar I had the opportunity of seeing all the cases, so that we discussed the question as to what was the cause of the increased frequency.

Pigmentation.

3499. There was no particular symptom that started you on the right track?—Soon after returning from my summer holidays, amongst my out-patients at Pendleton, I noticed in the men, when I was examining their hearts, that the nipples and areolæ were frequently black. I asked the men about this, and they said they had noticed it themselves. I think that was one of the earliest signs I myself personally observed in the autumn.

3500. Pigmentation of the areolæ of the breast?—Yes.

3501. Were rashes one of the things that attracted the medical officers of the infirmary, and put you on the track?—Pigmentation had been noticed in some of these cases of so-called peripheral neuritis before we realised that that pigmentation was due to arsenic.

3502. It was a review of the whole of the circumstances rather than any one particular symptom which put you upon the right track?—Quite so.

3503. When you saw Dr. Forsyth what information did he give you?—I called upon him on the evening of the 20th, and told him that these anomalous cases were due to arsenic. He had been seeing considerable numbers of these cases. Directly I told him what it was due to he realised in a moment that the solution of the cases was quite simple.

Catarrhal symptoms.

3504. Did he tell you what were the symptoms which had attracted his attention? We have already got it in evidence from Mr. Groves that his attention was drawn to the large number of his employees who were off duty, and on their benefit clubs, and he spoke to Dr. Forsyth about it, but he was not able to tell us what his employees were complaining of?—I understood from Dr. Forsyth that the chief symptoms of these men were irritation of the eyes and a slight irritation of the mucous membrane, nose, and so on; in fact, symptoms a little like influenzal symptoms.

3505. Catarrhal symptoms?—Yes. Dr. Forsyth also told me he had been seeing a number of cases of herpes, a much larger number of cases than he had met with among the poor of Salford before.

Herpes.

3506. What do you mean by herpes? Herpes as you and I know it, medically speaking? Was it herpes zoster, or herpes about the nose and lips?—No, herpes zoster, the true nerve herpes.

3507. That you would not consider probably an early symptom, would you? It would be secondary probably to nerve changes?—Apparently so, and yet in many of the cases, as far as I can gather, when they have had herpes, the neuritic symptoms have not been specially marked.

3508. Did he say that many of the brewery employees had been suffering from gastro-intestinal disturbance or not?—He gave me no idea of the numbers, but I gathered that some of them had.

Gastro-intestinal symptoms.

3509. Would not you expect before this disaster that before any serious amount of arsenical poisoning took place you would have got the history of gastro-intestinal irritation?—In the early days of the epidemic most of the practitioners firmly believed that the early symptoms of arsenical poisoning were manifested by gastro-intestinal symptoms, but in many of the cases I have inquired into the gastro-intestinal symptoms have been in abeyance. Another difficulty also presents itself, in that many of these people chronically suffered from gastro-intestinal symptoms. I spoke to one of our patients this morning who said he had vomited for many years every morning. He was in the habit of taking something like 12 pints daily.

3510. Still the absence of complaint on the part of these people of gastro-intestinal symptoms would render it less probable that the medical men whom they consulted would recognise it as being arsenic?—That was undoubtedly the case.

3511. How did you find that the cases at Heywood, Bacup, and Blackburn compared with yours?—The cases at Blackburn were apparently early cases, and comparatively slight. The cases I saw there were only in the catarrhal stage, and early neuritic irritation stage. I saw no cases of absolute paralysis there, neither did I hear of any.

3512. When did you first see cases of what you have spoke of as skin lesions, leaving out of account herpes or pigmentation; did they come early under your observation or late?—Looking over my notes, I find that early in the summer there were anomalous cases of skin lesion which I did not recognise as being arsenical, but the greater number of them seemed to come as regards Manchester in September and October.

3513. What was the nature of those lesions?—They were chiefly erythemas, but later on we got more extensive lesions. In fact, in one patient I have seen almost all the primary and secondary lesions of the dermatologists. Papular, vesicular, and pustular eruptions, callous, urticarial, scaly lesions and pigmentation, excoriations, and in some cases itching.

3514. Those cases of marked thickening of the cuticle on the hands and feet that you speak of as keratosis were rather late manifestations?—In some cases they were the symptoms that sent the patient to me. I remember one man distinctly coming to the out-patient department, and saying that his hands were getting so thick that he could not work. That was what struck his attention, but he also had some neuritic symptoms, which, however, had not specially attracted his attention.

3515. Were numbness and tingling of the extremity an early symptom?—Yes, and very common; the majority of patients coming as out-patients presented those symptoms.

3516. Speaking from your experience, how would these symptoms of numbness and tingling accompanied with skin eruption and followed by this thickening of the cuticle on different parts of the body compare with former cases of so-called alcoholic neuritis? Was it within your experience that you met with those symptoms I mentioned, the numbness and tingling to the same extent, the presence of rashes, and the presence of thickening of the cuticle in the cases of alcoholic neuritis which occurred during the eight years when you were pathologist?—In the former cases of alcoholic neuritis I cannot remember any case that had herpes. Very few of the cases presented distinct pigmentation. Erythemas were occasionally present, and the so-called erythromelalgia was sometimes met with. My attention was specially drawn to these cases because I happened to be, as a student, clerk to the late Professor Ross, who investigated these cases in Manchester, and in 1889 I was house physician to Dr. Dreschfeld, who, I believe, was the first to draw attention to peripheral neuritis occurring in beer drinkers in this district in 1884.

3517. So that a good many of these symptoms, according to your experience, has not been so marked in the old cases of alcoholic neuritis?—Pigmentation had not been marked; herpes had not been marked; and the lesions other than erythema had not been specially marked.

3518. That particular lesion of erythromelalgia you speak of you find in cases of nerve disturbance such as when a nerve has been divided?—That is so.

3519. You say in one rural district in which you saw cases where the beer contained as much arsenic as 1·4 grains per gallon the brewer early recognised the pernicious character of his beer. What do you mean by early recognised it?—This was a country district where the brewer superintended the making of his own beer, and he, in the autumn months, found that the men were passing his tied houses and, as he said, preferring tea to beer.

3520. By early you mean early in the year?—Yes, September, I think. I mean early in the outbreak.

3521. Did you find out whether he was using Bostock's material?—Yes, he was; but he did not know it, because he was getting it through an agent, and the agent was getting it from Bostock. He himself, therefore, did not realise until some time later the source of the sugar.

3522. Do you know what the effects of the beer he sold were on his customers that made him pass his house?—They knew there was something queer about it.

3523. (*Professor Thorpe.*) Where was this brewery?—It was not far from Warrington.

3524. What was the name of the brewery?—Might I explain just one point here? In our investigations we have acted as private individuals, and we have seen a number of brewers and others who, before any Royal Commission was spoken of, consulted us, and we feel as private individuals that a great deal that has been revealed to us was revealed to us in confidence. Therefore, whilst we are anxious to put everything before the Commission, might we be allowed to write such names down?

(*Chairman.*) Yes; you can hand it in and leave it for the Commission to decide.

3525. (*Sir William Church.*) What I want to know is what symptoms were produced in the people who got beer so highly contaminated as this was? Did the people who drank this very highly contaminated beer have vomiting and diarrhœa?—Some of them. I have a letter from the husband of a lady who had taken this beer which is rather interesting, as it gives the layman's idea of the commencement of the symptoms.

3526. I want to get evidence that the more grossly contaminated the beer the more quickly it was recognised that there was something unwholesome in it, and that more definite symptoms probably immediately followed. Whereas when it was less contaminated no symptoms followed for a considerable time?—I think this letter will be evidence. This was a lady who bought some of this beer from this brewery, bottled beer. She and her husband lived together, but her husband left her to go during the day to business in a neighbouring town. Both of them were affected, but she rapidly developed very marked paralysis, which is crippling her now. The husband has kindly sent me this letter, which I asked him to write after I saw the case in consultation with a doctor there. He wrote this on November 30th: "Agreeable with your wish, I give you in some detail the symptoms which have been noticeable in my wife's illness. Some six weeks ago, say October 19th, she was seized with vomiting accompanied by pain in the bowels and purging. That continued for two weeks, followed by difficulty in walking. She gradually got worse in that respect, and experienced very great difficulty in getting up and down stairs—to use her own expression, she felt as if she was walking on springs. Ultimately Dr. ——— was called in, and, after attending her a week or two, ordered her to bed, which she has kept since that time. While confined to bed she has suffered great pain in her lower extremities, and at the present time is unable to stand or walk. Her left foot is slightly turned in, and her hands are very much affected, they burn, and she is quite unable to grasp anything or hold a cup, etc. She is able to move her feet, but the movement causes pain. I should have stated that about the end of the second week she was seized with a violent pain at the bottom of the back. She has become considerably thinner, her arms and legs very much so. As regards myself, I do not suffer any great inconvenience, my feelings being confined to a tenderness and slight burning of the hands and a tingling in the soles of the feet. That has been my experience for some three weeks past."

Gastro-intestinal symptoms.

3527. That would go to show that where the beer was very much contaminated the gastro-intestinal symptoms were amongst the first noticed?—It does; and the beer of that brewery contained the largest amount of arsenic of any.

Individual susceptibility to, and tolerance of, arsenic.

3528. It has been suggested to the Commission by one witness that the great intolerance shown to the poisonous material, whatever it may be, in beer, led him to think it might be something else than arsenic. Do you think that, considering the enormous number of people who drank the contaminated beer in this district, there has been a very considerable amount of tolerance of arsenic?—I think the evidence goes to show that there certainly has been a certain amount of tolerance amongst many of the cases, but there is also evidence, of which we have had one or two cases, that patients manifesting an idiosyncrasy to arsenic prior to taking the beer, have been readily affected.

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3529. But apart from that. Considering the number of people who have been taking large amounts of contaminated beer, the population generally have shown a tolerance to arsenic, just as we should expect with people who were receiving small and constant doses or arsenic?—That is undoubtedly the case. The number of cases that have occurred compared with the large number of the population in Manchester and Salford is small.

3530. It has been suggested to the Commission that selenium or other substances must have been present to account for the tolerance?—I know nothing about the pharmacology of selenium.

Greater severity of disease in women.

3531. Have you any suggestions to give the Commission as to the reasons why these various cases have been more fatal in women than in men?—There are several explanations. First, I think women are naturally more liable to be affected with alcoholic neuritis, and in many cases these women have not had their excretory organs so active—they have not lost so much by sweating, and in many cases they have suffered from chronic constipation. Also, whilst the men in many instances have taken their beer from a number of public-houses, it is frequently the case, as we have distinct evidence to show, that the women got their beer from a definite public-house. I believe, too, amongst women in this district there is a very marked tendency to take large quantities of beer, and frequently between meals. They go to each other's houses, have a gossip, and the beer is sent in; so that between preparing their husbands' meals they take considerable quantities. I think those are the more particular reasons that explain the sexual differentiation.

3532. (*Dr. Whitelegge.*) You distinguish three stages in the history of the epidemic. Are those stages in the epidemic as a whole?—Yes.

3533. They do not refer to individual cases?—No, I shall refer to those presently.

3534. You mentioned some cases in Heywood which the medical officer of health said occurred in epidemic form immediately after the Whitsuntide holidays. They were not recognised as arsenical cases at that time?—No, not until after the Manchester cases had been recognised as arsenical.

3535. But those were earlier in date?—Yes. In fact, I saw cases there that dated their illness back to Easter, 1900.

3536. Definite arsenical cases?—Yes.

3537. On November 7th samples of beer from the rural districts to which you referred were submitted to analysis, and arsenic was found on November 17th. I believe that is an earlier date than has been given to us yet?—In making that statement, I quote from a published paper by Mr. Duncan, the analyst, who examined the special beer from this brewer to whom I have referred, and Mr. Duncan, in his published report, has stated that he found it on that date.

3538. Could you give us a reference to the report?—It is in "The Chemist and Druggist" for January 19th, 1901, page 93.

3539. Can you tell us what steps were taken by the brewer in question when this conclusion was arrived at?—I believe he took every step to prevent any further beer going out from his brewery. I cannot say anything with regard to the beer that he had sold.

3540. Can you give us the details?—No.

Cases in Manchester Royal Infirmary.

3541. You have given us figures of the cases observed at the Royal Infirmary?—Yes, during the months of November, December, and January.

3542. Would those be the whole of the cases observed there, including in-patients and out-patients?—These are only the in-patient cases, and, therefore, the bad cases. I might say that during this period of November, December, and January these cases formed 12·61 per cent. of the medical cases admitted.

3543. (*Sir William Church.*) Of course, there would be a large number of such severe cases in the out-patients' rooms?—A very considerable number were sent there, I believe; but I cannot speak to the out-patient department, because all my work is, as registrar, in connection with the in-patients.

3544. (*Dr. Whitelegge.*) Do you limit these figures to neuritis?—These 43 cases occurring during the months of November, December, and January were typical arsenical cases.

3545. Presenting symptoms of neuritis?—More or less. In some of them there was marked pigmentation and less neuritis. In some few there was no distinct pigmentation at all.

3546. Can you say how many fatal cases of Addison's disease there were in the year 1900?—As far as I remember there has been no case of undoubted Addison's disease in the infirmary, but I am not absolutely sure. My impression is that there has been no case during 1900.

3547. Do I understand you to say that Dr. Dreschfeld associated peripheral neuritis with beer drinkers in 1884?—Dr. Dreschfeld in 1884 published a paper which I think first drew attention to alcoholic paralysis in this district, and it is interesting to note that in giving the history of this first case recorded in this district he says: "Moreover, in her delirium she continually called out for beer." That is published in "Brain," Vol. 7. I might also add that in that same paper Dr. Dreschfeld in one or two places, in speaking of the differential diagnosis, refers to arsenic.

3548. (*Chairman.*) Have you anything to say with regard to the different stages of the disease?—According to the severity of the poisoning, the following stages have been recognisable:—(a) stage of muco-cutaneous irritation; (b) stage of neuritis; (c) stage of paralysis with atrophy and deformities; (d) stage of convalescence. A considerable number of cases presented little more than catarrhal symptoms. Many complained of irritation about the eyes and running of the nose. Nasal laryngeal and bronchial catarrh have been common, but marked gastro-intestinal irritation exceptional. Pigmentation was present in the majority of cases, and in some closely resembled that of Addison's disease. I understand a number of deaths have been registered as due to this complaint during the past year, and therefore, to ascertain its customary frequency in Manchester I have examined the pathological records of 1,478 "medical" cases investigated at the infirmary during the period I held the post of pathologist, and I find only three undoubted cases, or 0·2 per cent. The cutaneous derangements have been very multiform. Herpes has been one of the most characteristic. Keratosis or thickening of the cuticle has made a conspicuous figure. Erythromelalgia was common in the earlier stages. Of the neuritic manifestations the sensory derangements have generally been most troublesome, and usually preceded the motor. The form of paralysis has in the main been similar to that usually met with in so-called "alcoholic neuritis." Mental disturbances have been well marked in many patients. Heart failure has been present in bad cases. Cystitis and retention of urine has been present in a few instances. In no case, as far as I am aware, has the course of pregnancy been interfered with. A considerable number of the cases quickly recovered on the beer being withdrawn, but improvement has been very slow in many. Some are but now gradually passing into the stage of convalescence, and a number are yet under observation where the paralysis is still very extensive, and in some perfect recovery is unlikely. Many of the clinical points are clearly indicated in the series of drawings, photographs, and casts which I have placed on the table. The casts are of particular interest in that they have all been taken from patients under the care of Professor Dreschfeld. For purposes of comparison I have brought a few casts of "alcoholic" cases taken as far back as 1893, and these show that there is practically no difference in the muscles affected in arsenical and alcoholic paralysis, and that the consequent deformities are similar.

3549. Have you anything to say with regard to special cases?—I have seen two infants affected by arsenic through their mother's milk. One case was under the care of Dr. J. H. Taylor, of Weaste. The mother presented typical symptoms of arsenical poisoning. The other case was met with among my own out-patients. The infant was nine weeks old. The mother had been taking stout for five weeks. She presented the usual characters, pigmentation, erythema, and much sensory involvement. Analysis of the milk in both cases gave negative results. It has been generally stated that children have not been affected. This is not altogether the case. On December 2nd I saw, with Dr. John Brown, of Bacup, well-marked evidences of arsenical poisoning in a little girl of two. The child's father, who was also a sufferer, kept a public-house at which arsenicated beer was sold, and the child had been accustomed to get "sups" from the customers. I should

like to mention a curious case where poisoning occurred from the use of arsenical glucose in sweets. My informant is a brewer, who has rendered us much assistance in our investigations, and who has himself, together with several of his workpeople, presented evidences of arsenical poisoning. His beer has proved disastrous to a number of cases, several of which I have myself been able to examine. He writes me as follows: "I have a daughter about eleven years of age, and she and a niece made some toffy of this glucose, of which I believe my daughter ate the most. The first symptoms observed were sickness and purging, very violent. And when she went to school at ——, she was under the doctor. She was often sick, and they thought she was suffering from biliousness. After Christmas, when she was at home, her mamma was so alarmed about her, as she was getting so weak, that she took her to Dr. ——, of ——. I forgot she complained of stiffness in her legs. Dr. ——, after examining her, asked if she drank any beer, and was answered in the negative, 'Well,' he said, 'she seems to me to be affected with arsenical poisoning.' Afterwards we learned that she had helped to make and eaten this toffy. She now seems much stronger."

3550. You are a lecturer, are you not, on food inspection?—I give lectures on food inspection to students preparing for their Sanitary Inspectorships.

3551. Have any other cases come under your notice similar to that you have just quoted to us, before this outbreak took place or since?—That is the only case I know of where the poisoning from arsenic occurred other than through beer.

3552. You have not heard of any other case?—I know of no case occurring through sweets or confectionery.

3553. (*Sir William Church.*) How were the infants affected?—The infants were affected in that whenever they were put to the breast they immediately vomited after taking the milk. The eyes were running, and my own case was scabbed along the lids. The hands and feet were also slightly red. I stopped the suckling at once, and the mother informed me that there was no further vomiting. After a short while she continued to suckle the child, and the child did remarkably well.

3554. What was the age of the children?—In my own case the infant was nine weeks old, and in the other case the child was a few weeks old.

3555. It is a very common symptom for children to be sick after having had the breast, is it not?—Yes; but in this case both mothers were suffering from arsenical poisoning, and within a short time of their improvement the children got quite right. The child also had erythema and conjunctivitis, and there was also wasting.

3556. Had it any diarrhœa?—I am not prepared to say without referring to my notes.

3557. It seems to me one would want a little more proof than the mere fact of two children at the breast being ill in a way not uncommon with children at the breast, before one is quite sure they were suffering?—Both mothers were suffering acutely from arsenical poisoning.

3558. Has arsenic ever been found in milk?—Yes; and Professor Wood, in his work on Therapeutics, refers to the presence of arsenic having been found in a number of the excretions, sweat, and skin, and hair.

3559. You had not an opportunity of examining the milk yourself?—We obtained the milk on two occasions from the case, and my colleague, Mr. Kirkby, examined it. We had, of course, only a small quantity of milk, 1½oz. to 2oz., and no arsenic was found in the milk. The second sample was taken after all beer had been stopped.

3560. (*Chairman.*) I believe you have something to say with regard to dosage?—With regard to the important and interesting question of dosage it would seem that comparison between the amount of arsenic taken in medicinal preparations, and that consumed as arsenicated beer is apt to lead to fallacious conclusions. The effects of the arsenic upon the system in the recent outbreak have been considerably modified by concomitant conditions. Our investigations go to show that the peculiar circumstances of the introduction of the poison have led to an increase in the rate of absorption, to exceptional accumulation in the body, and to a retardation in its elimination. I am also of opinion that the alcohol, or other ingredients of the alcoholic beverages taken, has in many instances greatly accentuated the effects of the poison. A consideration of such circumstances will help to explain many cases where patients have only consumed very moderate quantities of beer or stout, and yet suffered severely. Of these I have seen several. The amount of arsenic in the various beers has varied greatly, even when the beer has come from the same brewery. This is clearly demonstrated by the Table on page 90 of our book, where the amount from brewery C has varied from 0·2 to 0·01 grs. per gallon. The amount of arsenic in the glucose and invert sugars varied from 0·03 to 0·05 per cent. Also the proportion of sugar used by different brewers to displace malt has varied from 10 to 50 per cent. Strange to say, many brewers seem to be in the habit of always mixing the sugars received from different firms. It is therefore readily seen that the arsenic present in the beer has varied within such wide limits that it is almost impossible to ascertain the exact amount taken by the patient. For instance, if a person drank a beer which contained ·14grs. per gallon, and took half a pint of this, that would mean only taking 1-100th of a grain of arsenic at a time. Many, however, have taken quite a gallon of beer daily, and that would mean something like a sixth of a grain daily. But some cases have come under our observation where beer has been taken from a brewer who was using 50 per cent. of contaminated glucose, and here the dosage was equal to 1·4gr. per gallon.

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3561. With regard to this varied quantity of arsenic found in beer manufactured by one brewer, it might be perfectly true, but at the same time you are of opinion that the only real security is to allow no arsenic whatever in any material used for brewing?—Certainly; as defined by a statutory test.

3562. You would have a statutory test applied?—Certainly.

3563. And apply that test in the form of an analysis of all material used in brewing?—Certainly.

Effect of administration of arsenic and alcohol together.

3564. (*Sir William Church.*) What leads you to the opinion that alcohol or other ingredients of alcoholic beverages has in many instances greatly accentuated the effects of the poison?—First, that in those cases that were very moderate drinkers the symptoms subsided much more rapidly than in the excessive drinkers; also, in some of my patients when I knocked them off the beer I found they were not improving as I expected, and on inquiry I found they had transferred their affections to rum and spirits. In one or two cases I found a man who had been improving relapsed, and on inquiring I found he had returned to his beer, fully understanding that the beer now contained no arsenic, and yet it brought back his sensory symptoms and symptoms to a slight extent of erythema.

3565. It comes to this, then, that you think the person who does not use alcohol at all, or at all events not in large quantities, possesses extra powers of resistance. You did not think that the fact of the alcohol and arsenic being ingested together caused the arsenic to have special virulence?—I have only formed the opinion as regards the clinical facts, which seem to give an explanation.

3566. It has been stated by many other witnesses that they thought the ingestion of alcohol and arsenic together was likely to be more deleterious than the ingestion of arsenic alone?—I am convinced of the fact as evidenced in my own patients, but as to how this association acts I am not quite sure.

Instance of rapid development of symptoms.

3567. (*Dr. Whitelegge.*) Why do you think that the absorption of arsenic is more rapid?—The absorption of arsenic, we think, is more rapid than in the case of medicinal doses, in that apparently the vehicle has exerted some influence, because in many of these cases I have endeavoured to take the data, and have found in one or two cases that these symptoms of arsenical poisoning developed in one case within a week, and in one or two other cases within a fortnight. We know approximately what amount of arsenic those beers contained, and medicinally speaking we do not generally get with roughly comparable doses symptoms of arsenical poisoning within a week. In the case of a man who came from Canada and landed in this country on September 10th, within a fortnight he had very distinct symptoms. I saw him in Heywood and in six weeks he had very marked and distinct pigmentation.

3568. From what circumstances do you conclude there is exceptional accumulation in the body?—My colleague Mr. Kirkby has examined specimens of skin taken from patients, and in several of these we found what I think I might call a considerable amount of arsenic. In one case, for instance, a comparatively small quantity of scales gave a very distinct mirror with Marsh.

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3569. And gave results you did not expect to find from ordinary medicinal administration of arsenic?—Not from my own experience.

3570. You have not any precise comparative results?—Not at present.

3571. Why do you say there is a retardation in the elimination? Is that based on experiment?—Yes. It is generally believed that arsenic is excreted rapidly, but our recent experience has conclusively shown that arsenic may act as a cumulative poison. Mr. Kirkby has carried out a series of analyses with regard to this point, which show that a continuous elimination of arsenic by the kidneys may occur during a period of six weeks after stopping all contaminated beer. In a patient of Dr. Dreschfeld's after five weeks residence in hospital, arsenic was obtained from the desquamated skin in such quantity as to give a very distinct mirror with Marsh's test. It has been detected in the hair of a number of the cases, and, as already indicated, it can pass into the milk of suckling mothers in sufficient quantity to cause poisonous symptoms in their infants.

Excretion of arsenic.

3572. (*Chairman.*) How many years were you pathologist at the infirmary?—From early in 1891 to nearly the end of 1899, since which period I have been medical registrar. My connection with the infirmary has, therefore, been continuous since 1891, and I have known of cases there as a student and hospital resident.

3573. There is one important part of your *précis* which we should like you to enlarge upon, as, if it be a fact, it is important. I refer to your statement that in this particular district for many years past, and long before this outbreak took place, there were a large proportion of these symptoms as compared with other districts in the country?—When pathologist at the infirmary, I was much struck by the large number of cases coming under observation with alcoholic lesions. As far as could be ascertained they were nearly always beer drinkers. I then formed the opinion and constantly taught that either the drinking habits of the people or the character of the beverage in this district was more fruitful in pathological results than appeared to be the same elsewhere. In 1895 ("Medical Chronicle," December, 1895, p. 180) I collected the fatal cases of alcoholic neuritis which had been submitted to post-mortem examination during the preceding three years. Eight cases had been examined. They formed 1·6 per cent. of all the medical cases examined during that period. All were females. The average age was 39. The oldest was 57, the youngest 24. I have the reference to these cases here. As it has been stated that phthisis has been hastened in certain of the recent arsenical cases it is interesting to note that of these eight fatal cases, seven were the subjects of pulmonary tuberculosis. It may not be without interest to add that in 1897 I collected 121 cases of common cirrhosis of the liver from amongst our pathological records of 3,053 medical cases. In these, either active, latent or obsolete, tubercle was met with in nearly 24 per cent., and over 12 per cent. died from active tuberculosis. It also seems to me a very suggestive fact that we have for long looked upon "alcoholic heart" as a particularly well marked pathological condition, and easily recognised clinical affection in Manchester beer drinkers. In the following tables I have indicated the number and relative frequency of cases of peripheral neuritis amongst the patients of the Manchester Royal Infirmary since 1892 as recorded in our official returns:—

Alcoholic neuritis in Manchester Royal Infirmary in previous years.

Frequency of Peripheral Neuritis amongst Medical In-Patients of the Manchester Royal Infirmary.

Year.	Total Cases.	Number of Peripheral Neuritis.	Percentage.
1892	1,376	21 (a)	1·52
1893	1,374	23 (b)	1·67
1894	1,286	17 (c)	1·306
1895	1,249	16	1·28
1896	1,317	13 (d)	0·98
1897	1,286	12	0·93
1898	1,412	7	0·49
1899	1,300	21	1·61
1900	1,343	62	4·61

(a) Of these 21, 12 are definitely returned as "alcoholic neuritis."
(b) " 23, 20 " " " " "
(c) " 17, 13 " " " " "
(d) " 13, one was considered as probably post-diphtheritic, another possibly syphilitic.

As regards the year 1898 I have been somewhat perplexed, as the numbers then fell to seven, a percentage of ·49. I believe it has been stated before your Commission that the number of deaths from alcoholism in 1898 in this district was smaller than in previous years. If that is so, it would help me out of the difficulty of explaining this fall in the cases. I endeavoured to check that by taking the home patients, visited at their own homes. I find in 1894 the percentage was 0·52, but in 1898 there was only one case, whereas in 1899 the percentage again went up to 0·46, and in 1900 there were 76 cases of peripheral neuritis returned as having been seen in their own homes, a percentage of 9·22.

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3574. (*Chairman.*) That was apparently a period during which this epidemic took place?—That is so. But, even taking the whole of our cases, 11,943 cases, since 1892, I find we have 192 cases, with a percentage of 1·59. It is quite possible that one or two of these may have been post-diphtheritic.

3575. Were those cases of peripheral neuritis?—Yes.

compare with oth Hospital

3576. (*Chairman.*) I understand you have sought to compare the Manchester experience with that of other districts. Could you give us the result of your comparison?—Yes. Reliable statistical evidence, as might be expected, is somewhat difficult to obtain, but such as has been forthcoming tends to show that Manchester and district has long enjoyed an unenviable prominence as regards the frequency and severity of its cases of peripheral neuritis. I have endeavoured to take what I may term characteristic centres. London experience, as indicated in the official reports of St. Thomas's and St. Bartholomew's Hospitals, shows that for the years 1893-1896 about ½ per cent. of the medical in-patients were returned as suffering from peripheral neuritis. Professor A. Carter, of Birmingham, has kindly sent me returns of the Queen's Hospital, from which it appears that between 1891 and 1900, 84 cases were registered as "alcoholic," "peripheral," or "multiple," and therefore presumably of similar character. Through the kind intervention of Professor Sims Woodhead I have been furnished with the returns of cases of alcoholic neuritis in Addenbrooke's Hospital, Cambridge, which may be taken as representative of the experience of our eastern counties. Between 1878-1901, 26 cases of alcoholic neuritis were returned, 11 being males and 15 females. The average age of the men was 48·72, that of the women 41·46. Of the total cases only 0·28 per cent. of peripheral neuritis occurred, 0·27 per cent. males and 0·29 per cent. females. Through the kindness of Dr. Burton Fanning, of the Norfolk and Norwich Hospital, I have learnt that in that institution, since 1890 only 25 cases of peripheral neuritis have been met with. With many of these cases it has been difficult to be sure of the exact form of drink taken, but 5 are definitely recorded as beer drinkers, and 3 admitted taking beer and spirits. In Cornwall "alcoholic" neuritis seems to be almost unknown. Dr. J. B. Montgomery, of the Cornwall Dispensary and Infirmary, Penzance, in over 50 years' experience has recollection of only one case. If peripheral neuritis was commonly due to alcohol, it should be frequent in Scotland. As far, however, as I can ascertain, such is not the case. While whisky appears to be the popular drink, I am informed on reliable authority that a good deal of beer is also consumed. Dr. Mackie Whyte has very kindly sent me an analysis of the cases of alcoholic neuritis in Dundee Infirmary during the last three years. Out of about 9,000 patients, 9 cases were met with, which gives only 0·1 per cent. In 5 of the cases "spirits" was stated as the cause. That peripheral neuritis is, however, not unknown in Edinburgh is clear from the fact that Dr. Clouston, superintendent of the Royal Asylum, Morningside, is able to report that for the year 1900, 13 per cent. of the male and 9 per cent. of the female alcoholic patients exhibited symptoms in varying degrees. Dr. Wiglesworth, of the Lancashire County Asylum at Rainhill, writes me that for the two years, 1899 and 1900, the proportion of well-marked peripheral neuritis in the strictly alcoholic cases was 2·27 per cent. for the males and 4·76 per cent. for the females. Multiple neuritis would appear also to be rare in Ireland. Professor J. A. Lindsay, of Belfast, has sent me very carefully-prepared statistics of the cases met with in the Royal Victoria Hospital from 1892-1899, showing that during that period only 25 cases have been met with amongst the in-patients, which give a return of 0·29 per cent. Professor W. E. A. Cummins, of Queen's College, Cork, informs me that alcoholic neuritis is very infrequent in that city,

although "porter is the usual beverage taken by the lower classes, not whisky." I have endeavoured to obtain particulars of the occurrence of peripheral neuritis in America, where I believe much of the beer taken is prepared from glucose and invert sugars. Professor Osler, of Baltimore, has very kindly sent me a preliminary announcement, in which he says: "We see very little severe alcoholic neuritis, and it is my experience, I think, entirely in whisky drinkers. . . . I do not remember at the moment ever to have seen in this country a case of alcoholic neuritis from beer." An arrangement of these results in tabular form shows at a glance that for nine years at least peripheral neuritis has been common in Manchester:—

ANALYSIS OF CASES OF PERIPHERAL NEURITIS OCCURRING IN-PATIENTS IN VARIOUS HOSPITALS.

Hospital.	Years.	No. of Cases.	No. of Peripheral Neuritis.	Percentage
Royal Infirmary (Dundee).	1899-00	9,060	9	0·1
Addenbrooke (Cambridge).	1878-01	9,096	26	0·28
Royal Victoria (Belfast).	1892-99	7,928	23	0·29
St. Thomas' (London).	1893-96	7,656	37	0·48
St. Bartholomew's (London).	1893-96	10,009	52	0·51
Royal Infirmary (Manchester).	1892-98	9,300	109	1·17
Ditto - - -	1899	1,300	21	1·61
Ditto - - -	1900	1,343	62	4·61

For the years 1892-1898 it accounted for 1·17 per cent. of the in-patients in the Royal Infirmary. In 1899 this rose to 1·61, and last year it was 4·61 per cent. It would therefore seem as though cases of peripheral neuritis had for long been from five to ten times more numerous here than in Belfast and Cambridge and Dundee, and more than twice as frequent as in London. A recognition of such facts has led to the suggestion that poisoning from arsenicated beer has been occurring for some time prior to the recent outbreak, and such indeed seems very likely, but I cannot agree with the view that alcoholic paralysis—which we know has been recognised in this country for over a hundred years (Lettsom, J. C., "History of some of the Effects of Hard Drinking," London, 1789), and has been described in America (Jackson, James, "On a Peculiar Disease resulting from the use of Ardent Spirits," "New England Journal of Medicine and Surgery," Vol. XI., Boston, 1822)—has throughout been due to arsenical contamination of the alcoholic beverages.

3577. (*Chairman.*) Do you draw a conclusion from that that there has been something in the quality of the beer consumed in Manchester that has caused this increased percentage of the disease?—As I taught my students long since, and I am still of the same opinion either in the quality of the beer or from the drinking habits of the people there must be something to account for the increased proportion. I am, naturally, unable to compare the drinking habits of Manchester with London, but I should imagine that as regards mere quantity there would not be much difference.

3578. (*Professor Thorpe.*) With reference to that last statement, I suppose the Revenue returns would show how far there was a great increase in the consumption of beer?—I imagine that would be the case, but I have not looked up these returns.

3579. You would be at once able to satisfy yourself on one of the issues that you put to yourself by simply consulting the Revenue returns?—To some extent as regards quantity; I am not quite sure as regards times. For instance, the women here drink much between meals. I do not know that those medical details would come out.

3580. The only point that would come out would be the total amount of beer consumed?—Quite so. I think the whole circumstances of the way in which the beer has been taken has had a great effect.

3581. (*Sir William Church.*) Is ascites a common cause of death in Manchester?—We get a considerable number of cases of ascites in cirrhotic livers, but the majority of our cirrhotic livers are not of the old fashioned gin-drinker's type. *Dr. T. N. Kelynack.* 25 Mar. 1901.

3582. You mean they are not contracted livers?—They are not contracted livers. The majority of them are what we call enlarged fatty cirrhotic livers.

3583. I notice that among those cases that you referred us to, that are published, there are some cases that had livers under the normal weight—two?—Yes. I have met in the *post-mortem* room with thorough atrophic cirrhosis, contracted "hob-nail" livers, but the majority of the cases that we get are enlarged and fatty cirrhotic livers. Cirrhosis of liver.

3584. I think your experience is that the cases occurring in this district with ascites, without accompanying heart disease, are generally associated with large and fatty livers rather than with small and contracted ones?—That is so; and also I have seen as a pathologist a large number in alcoholic subjects dying from pneumonia, and alcoholic heart, in which the livers were enlarged, fatty, and cirrhotic.

3585. Besides the condition of the liver, are there any other conditions which you associate with alcoholism in the internal organs as recognisable after death?—In this part of the country we frequently see the so-called "alcoholic heart," the enlarged heart, hypertrophied and dilated with degenerate muscle, and nearly always occurring in beer drinkers. Degeneration of heart muscle, "Alcoholic Heart."

3586. Do you know what is the supposed action of arsenic upon the heart muscle?—It brings about fatty degeneration, and that is very much the appearance that we find on microscopically examining the muscles of these so-called "alcoholic hearts."

3587. As far as your experience goes, you would say that the hearts of patients that you have thought have been alcoholic have not been so remarkable for what is called fatty infiltration, but for fatty degeneration?—In many cases the two pathological processes have been associated—fatty infiltration and fatty degeneration, but although I have not examined them all microscopically, from those that I have examined I am convinced that fatty degeneration is a very important element in what we clinically know as "alcoholic heart."

3588. You say that alcoholic neuritis has been recognised for 100 years. I suppose you mean by that that the first descriptions almost that we have of it, Dr. Letsom's, are 100 years old, but you do not wish the Commission to understand that alcoholic neuritis has been recognised generally for 100 years in England?—The description of Dr. Letsom, over 100 years ago, is what we now know to be alcoholic neuritis; but I think it is generally accepted that it only came into the nomenclature of diseases in 1885, if I remember rightly. Introduction of Alcoholic neuritis into nomenclature of disease.

3589. It was recognised before it came into the nomenclature of disease, but until it came into the nomenclature of disease it was not generally recognised by practitioners?—Not by the profession as a whole.

3590. Therefore the experience 50 years ago of your Cornwall correspondent goes for very little more than 15 years' experience?—Yes, unless, of course, his memory was retrospective.

3591. And unless he was acquainted with the fact of alcoholic neuritis?—Yes.

3592. I suppose you would agree with me that 15 years ago the large majority of practitioners in the country did not recognise it?—That is so. In this particular case of Dr. Montgomery, it was father and son who were in medical practice, and if there had been analogous cases of paralysis probably they would have them in their notes and be able to carry them retrospectively. Alcoholic neuritis in various parts of the country.

3593. You asked for analogous cases of paralysis, not for alcoholic paralysis?—I think in asking I asked for alcoholic neuritis. I would leave it to them.

3594. Did you get any other information from Cornwall?—I had the information that they were greater tea drinkers than alcohol drinkers. I believe a large number of the population are abstainers.

3595. Did you inquire of Dr. Montgomery because of the connection that Cornwall has with the manufacture of arsenic?—Partly with that idea.

3596. Do you know whether many workers in arsenic came under Dr. Montgomery's notice?—I cannot tell, so far as the Penzance district is concerned.

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3597. With regard to the information you got from London, in what terms did you ask for it?—I took the returns of St. Thomas's and St. Bartholomew's from the published hospital reports.

3598. I cannot answer for St. Thomas's, but I think in St. Bartholomew's reports the alcohol cases are enumerated separately from the other peripheral cases. I am not certain, but I think that under the head of multiple neuritis there are two sub-headings—alcoholic and multiple?—I can give you the exact numbers.

3599. It is not the numbers we want, but rather the way in which you abstracted those figures from large statistical tables?—I have a table here which I had prepared for my own purposes of reference. It shows the way in which they are given in the hospital reports.

3600. That is just the point I wanted to know; these are medical cases of neuritis?—Yes, under the head of alcoholism at St. Bartholomew's.

3601. You only extracted the ones under the head of alcoholism?—Yes; I think they call it alcoholic paralysis.

3602. I ought to know myself in the case of St. Bartholomew's but I do not feel clear at the moment. All that I wanted to bring to your attention was that unless they were spoken of as alcoholic a large number of the cases of neuritis at St. Bartholomew's would be diphtheritic?—Quite so, but I took care to exclude those. These are all under the head of alcoholism; the diphtheritic ones I think you will find separately.

3603. Have you had an opportunity of getting any information from Poor Law infirmaries?—I have endeavoured to do so, but, unfortunately, statistics do not seem to be available.

3604. The cases from Poor Law infirmaries would be, perhaps, more comparable with your figures here than those from hospitals, would not they?—That is the case, but I am afraid statistics are not available. I have endeavoured to get them from the East-end of London, for instance.

3605. (*Dr. Whitelegge.*) Have you been able to ascertain the percentages for Birmingham or Norwich?—Professor Carter, of Birmingham, has kindly sent me the numbers, but hitherto I have unfortunately not been able to get the full number of the medical cases in order to work out the percentage.

3606. You have obtained the numerator, but not the denominator?—Quite so? I should like to say that when I was working out the cirrhosis of the liver cases it was partly the experience of Birmingham that led me to look up our Manchester cases. Dr. Foxwell had been working at them in Birmingham, and I find that as regards cirrhosis of the liver our Manchester experience apparently is very similar to that of Birmingham, but as to the percentage I am sorry to say I have not got that of Birmingham.

3607. In the case of Cornwall, did you make application to any other surgeon than the one whose figures are given?—I have not done so.

3608. You did not make any application to Plymouth or Tavistock?—No.

3609. The Devonshire towns, probably, would receive the cases from the east of Cornwall?—Yes; in fact I was anxious more to get the neuritis, which is looked upon as alcoholic, and to keep out any that might be due to arsenic in the arsenic centres.

3610. I gather that you have obtained the figures from Cornwall and Penzance rather by reason of their association with arsenic; it was alcohol that you wanted?—I think Sir William Church referred to that. I meant to say that I wanted to know whether there was any alcoholic neuritis or evidence of arsenical beer.

3611. No relation to the local arsenic?—No.

3612. (*Sir William Church.*) I thought it was with reference to the arsenic?—And that is why, of course, I went to Penzance rather than to the other places.

3613. (*Dr. Whitelegge.*) To keep out of the way of the arsenic?—Yes.

Beri-beri and arsenic.

3614. With reference to Dublin, in your book you mention beri-beri. Have you followed that up at all? Have you seen beri-beri?—Dr. Conolly Norman very kindly sent me a copy of his pamphlet, which contains a description of the outbreak in the Richmond Asylum, Dublin. At the time, of course, I carefully went through it, especially as we know that some of the arsenical cases have been confused with beri-beri; but as far as I can gather from his cases, although the photographs are somewhat similar to our cases, there is no distinct evidence to show that his outbreak was arsenical, for I find no reference whatsoever to pigmentation, for instance, and such skin lesions as we have met with here. I have also looked up Dr. Manson's work, who may be considered to be one of the authorities on beri-beri. I may also say that Dr. Manson has seen some of our cases here, and in his book on tropical diseases, in giving a description of beri-beri, he makes no reference to pigmentation. Of course, pigmentation would be difficult to see in a dark-skinned race.

3615. You could see nothing approaching the ordinary œdema of beri-beri in the recent cases here?—No, but I should like to say in that connection that in the alcoholic hearts that we have here we get curious œdemas. I have seen localised œdema of the chest, and the œdema even localised to the scalp.

3616. Frequently?—Not frequently.

3617. As an exceptional condition?—Yes.

3618. The Royal Infirmary figures of 1898 were rather exceptional, were they not, in giving a lower proportion than usual of neuritis cases?—They were very exceptional.

3619. I see there is another peculiarity in the figures of that year; the total number of medical cases was greater than in any other year. Was there any crowding of the infirmary during that year that would account for the exclusion of neuritis cases?—Not that I am aware of.

3620. There was nothing exceptional?—No.

3621. The total number of cases reported was larger in that year, was it not?—Yes, I noticed that myself, but I am not aware of its exact cause. I endeavoured to check that point by turning to the returns of the home-patients, and I found that in the home-patients in the year 1898 only one case of peripheral neuritis was met with by the visiting medical officers, which seemed to show that they were not kept out of the infirmary by crowding with influenza or pneumonia patients.

3622. (*Chairman.*) You conclude, I believe, with a suggested remedy against the catastrophe that has lately visited their neighbourhood. You suggest, do you not, that as sulphuric acid is liable to contain arsenic, that, therefore, in all cases where it is to be applied for food purposes or for beer there must be some security that it is arsenic free?—That is so.

3623. You approve that suggestion thoroughly?—Thoroughly.

3624. You say: "It is desirable that analytical laboratories be established directly under the control of the local authorities, but subject to systematic inspection by experts acting under the direction of the central authority." Do you approve of that suggestion?—Yes.

3625. Who do you refer to as the central authority—the Inland Revenue or the Local Government Board?—The Local Government Board.

3626. This should be a systematic inspection on the part of the Local Government Board as the central authority of all these analytical laboratories?—Yes. There should be local analyses which might be directed and checked by experts appointed, and reporting to a central authority. It is not a question merely, I take it, of sulphuric acid, but, as I have suggested, sulphuric acid and all materials used in the manufacture of beer and food products should be required by law to be arsenic free as indicated by a statutory test, and that for the enforcement of the same it is desirable that analytical laboratories be established directly under the control of the local authorities, but subject to systematic inspection by experts acting under the direction of the central authority.

3627. You would subject these materials, whatever they may be, to a secure test; that is to say, at all stages you would not be satisfied with any analyses of the product, but you wish to establish a system whereby all materials would be tested which might by any possibility contain arsenic?—I take it that in connection with the local control the final products would be tested, and that those chiefly would be subjected to analysis. I take it, further, that the makers of these food products would throughout, from the commencement of the manufacture to the final form of the food product, for their own purposes see that they had adequate analysis proving the purity of their materials.

Mr. WILLIAM KIRKBY, called; and Examined.

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3628. (*Chairman.*) I believe you are a Fellow of the Linnean Society, a Fellow of the Royal Microscopical Society, a pharmaceutical chemist, and lecturer on pharmacognosy at Owens College, Manchester?—Yes.

3629. I think you have taken a prominent part in the analytical work connected with this inquiry?—I have.

3630. We shall be glad if you will give us the results of some of your inquiries?—I had some of these suspected beers submitted to me by Dr. Kelynack, and I immediately found that there was a difficulty in analysing them in the ordinary way, that is, by using Marsh's test and Reinsch's test. I saw the necessity of finding out the most delicate method that could be used for detecting arsenic, and I therefore had recourse to Gutzeit's test, which consists of acting upon zinc with either hydrochloric acid or sulphuric acid for the evolution of hydrogen, and in the presence of arsenic there is produced arseniuretted hydrogen, which, acting upon a piece of paper moistened with silver nitrate or mercuric chloride, gives characteristic colours. I adopted the mercuric chloride, which is an improvement on the older method of using silver nitrate. My experience confirms the fact that it is an improvement. Because of the difficulty I had in detecting arsenic with the ordinary tests I had recourse to Guizeit's test, by means of which I obtained the results set forth in my communication and in the book which Dr. Kelynack and myself have published. The opportunities for applying this test and arriving at an estimate of its value have been great. One of the largest breweries in the Manchester district submitted for examination all the different beers which they had upon the premises, as well as others which were specially brewed, with a view to elucidate the matter in hand, and in order to estimate aright the influence of sulphur compounds which are apt to interfere with the test. I made a considerable number of experiments, and I had a sample of beer brewed with an average amount of glucose free from arsenic and a good proportion of sulphurous preservative. I may say that the quantity used was about an ounce of potassium meta-bisulphite to the barrel; I was able in that way to estimate the amount of influence the sulphur compounds would be likely to have in invalidating the test. From the figures which I have given, I think it will be clear that I have been able to come to a safe conclusion with regard to the quantities which I have stated were present in the beers. Although a process of estimation such as this appears to lack that definiteness which is ascribed to a gravimetric analysis, it is questionable if really it is less accurate when the numerous operations of a gravimetric analysis are considered. But no further claim is made for the following figures than that they are close approximations to the actual proportion of arsenic present in the beers. In order to safeguard an important examination of this character and to arrive at results which might be presented with some degree of confidence, it has been necessary to make many hundreds of experiments. In the following tables the results of the estimations are expressed in grains of arsenious oxide (white arsenic, As_2O_6) per gallon. From a purely scientific point of view it would, perhaps, have been preferable to use the element arsenium (As) as the basis of calculation, but I have adopted the former alternative in order to facilitate a correct apprehension of the dosage.

TABLE of BEERS, PORTERS, STOUT, &c.

BREWERY A.

Article.	Arsenious Oxide, Grains per Gallon.	Remarks.
1. Draught beer	Nil	Bought since outbreak.
2. „ „	„	„ „ „
3. Bottled ale	0·04	Bought Nov. 27.
4. „ „	Faint trace	From brewery; brewed Aug. 8.
5. „ „	0·18	„ „ „ Nov. 9.
6. „ „	0·28	„ „ Oct. 29.

BREWERY B.

Article.	Arsenious Oxide, Grains per Gallon.	Remarks.
7. Draught bitter	Nil	From brewery; brewed Nov. 15.
8. Bottled stout	Very faintest trace.	„ „ „ „ 7.
9. Pale ale	Faintest trace	„ „ „ „ 14.
10. Draught stout	0·03	„ „ „ „ 14.
11. Pale ale	0·16	Bought Nov. 15.
12. Draught ale	1·40	From brewery, September.

BREWERY C.

Article.	Arsenious Oxide, Grains per Gallon.	Remarks.
13. Beer	Nil	From brewery; malt only.
14. „	„	ditto ditto.
15. Wort	„	ditto ditto.
16. Beer	„	ditto ditto.
17. „	„	ditto ditto.
18. „	Very faintest trace.	ditto ditto.
19. „	Very faintest trace.	ditto ditto.
20. „	0·01	ditto Malt and Glucose.
21. „	0·04	ditto ditto.
22. „	0·04	ditto ditto.
23. Pale ale	0·05	ditto ditto.
24. Beer		ditto ditto.
25. „	0·07	ditto ditto.
26. „	0·07	ditto ditto.
27. „	0·08	ditto ditto.
28. „	0·09	ditto ditto.
29. „	0·09	ditto ditto.
30. „	0·10	ditto ditto.
31. „	0·11	ditto ditto.
32. Stout	0·14	ditto ditto.
33. Beer	0·14	ditto ditto.
34. „	0·14	ditto ditto.
35. „	0·14	ditto ditto
36. „	0·18	ditto ditto
37. „	0·20	ditto ditto.

BREWERY D.

Article.	Arsenious Oxide, Grains per Gallon.	Remarks.
38. Stout	Faintest trace	From brewery.
39. Bitter beer	0·07	ditto.
40. Best XX	0·07	ditto.
41. Common X	0·09	ditto.

BREWERY E.

Article.	Arsenious Oxide, Grains per Gallon.	Remarks.
42. X ale	Nil	From brewery.
43. Stout	„	ditto.
44. Luncheon ale	„	ditto

BREWERY F.

Article.	Arsenious Oxide, Grains per Gallon.	Remarks.
45. Best beer	Nil	From brewery
46. Stout	„	ditto
47. Common beer	0·03	ditto.

BREWERY G.

Article.	Arsenious Oxide, Grains per Gallon.	Remarks.
48. Beer	Nil	From Brewery.

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BREWERY H.

49. Beer - -	Faintest trace -	From brewery.

VARIOUS.

Article	Arsenious Oxide, Grains per Gallon.	Remarks.
50. Beer - -	Nil - - -	Bought.
51. „ - - - -	„ - - -	- ditto.
52. „ - - - -	„ - - -	- ditto.
53. „ - - - -	„ - - -	- ditto.
54. „ - - - -	„ - - -	- ditto.
55. „ - - - -	„ - - -	- ditto.
56. „ - - - -	„ - - -	- ditto.
57. „ - - - -	„ - - -	- ditto.
58. „ - - - -	„ - - -	- ditto.
59. „ - - - -	„ - - -	- ditto.
60. „ - - - -	„ - - -	- ditto.
61. „ - - - -	„ - - -	- ditto.
62. „ - - - -	„ - - -	- ditto.
63. „ - - - -	„ - - -	- ditto.
64. „ - - - -	„ - - -	- ditto.

FROM PATIENTS.

65. Beer - - -	Nil - - -	Brewery A. November 28.
66. „ - - -	0·02 - - -	- ditto.
67. „ - - -	0·03 - - -	- ditto.
68. Stout - -	0·04 - - -	- ditto.
69. Beer - - -	0·07 - - -	Brewery C
70. „ - - -	0·07 - - -	
71. Porter - -	0·08 - - -	Brewery C. November 28.
72. Beer - - -	0·14 - - -	Brewery A.
72. „ - - -	0·14 - - -	- ditto.

The various beers, etc., may be placed in four groups:

(*a*) Exceeding 0·1 ($\frac{1}{10}$) gr. As_4O_6 per gallon.

(*b*) Exceeding 0·03 ($\frac{1}{30}$) gr. As_4O_6 per gallon, but less than 0·1 ($\frac{1}{10}$) gr.

(*c*) Less than 0·03 ($\frac{1}{30}$) gr. As_4O_6 per gallon.

(*d*) Gave no reaction in one hour by the method adopted, and returned as arsenic free.

The specimen marked No. 12 is worthy of special notice. It was speedily recognised as having a very unusual effect upon the persons drinking it, and as early as November 7 the brewer had it submitted to analysis, but nothing deleterious was found in it. However, other samples were sent for examination, and there were variously reported upon as severally containing 0·8gr. (approximately) per gallon, 1·12gr. per gallon, and 1·36gr. per gallon. Without any previous preparation this beer gave a distinct mirror in a Marsh-Berzelius tube upon being heated for one hour; there was no difficulty in obtaining distinct recognisable crystals of arsenious oxide with Reinsch's test. Nos. 18 and 19 were brewed from all malt and hops, but were nevertheless contaminated with arsenic. The brewing materials of this particular firm were, with the exception of the brewing sugars, found to be free from arsenic. Subsequent brews, however, have been found to be free from arsenical contamination. The suggestion that arsenic is present in the brewing apparatus, such as indiarubber tubing, is worth investigating; but a much more likely source of contamination is to be found in the wooden plant of the brewery, which has been used for brewing arsenical beers for at least several months, as well as in the yeast, which will probably be found to be contaminated with arsenic after having undergone a period of fermentation in an arsenical beer.

Arsenic perhaps remains in brewing plant

BREWING GLUCOSE AND INVERT SUGAR.

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Article.	As_4O_6 per Cent.	Reaction with Litmus.
ENGLISH.		
1. Invert sugar -	Nil	Acid.
2. „ - -	„	Neutral.
3. „ - -	0·03	Acid.
4. „ - -	0·03	„
5. „ - -	0·04	„
6. Glucose - - -	Nil	„
7. „ (for stout) -	„	„
8. „ - - -	„	„
9. „ - - -	0·04	„
10. „ - - -	0·05	„
11. „ - - -	0·05	„
AMERICAN.		
12. Glucose - - -	Nil	Faintly acid.
13. „ - - -	„	Neutral.
14. „ - - -	„	„
15. „ - - -	„	„
16. „ - - -	„	
17. „ - - -	„	
18. „ - - -	„	„
19. „ - - -	„	„
20. „ - - -	„	„
21. „ - - -	„	„
UNKNOWN ORIGIN.		
22. Glucose - - -	Nil	Acid.
23. „ - - -	„	„
24. „ - - -	Faintest trace.	„
25. „ - - -	„	„
26. „ - - -	„	„

The proportion of sugar used for displacing malt varies within very wide limits. Some brewers do not exceed 5lb. of sugar per barrel of 36 gallons; this quantity represents about 10 per cent. of malt. Others, however, use very much more, displacing as much as 30 or 40 per cent. of malt. In one instance we have found as much as 50 per cent. of the malt to be substituted by sugar. Beer No. 12 was brewed from produce of these proportions. Arsenical glucose, containing 0·04 per cent. of arsenious oxide, was used; the quantity of beer produced at the gravity stated by the brewer indicated that it contained the soluble matter of ¾lb. of sugar per gallon—equivalent to 2 gr. of arsenious oxide. From the table it will be seen that analysis only discovered about three-quarters of this quantity. It is extremely likely that the yeast is responsible for some of the deficiency as well as the brewing plant, which has certainly been found to contaminate subsequent brews made with arsenic-free ingredients.

Amount of glucose used in inculpated beers.

3631. You say as early as November 7th the brewer had this beer submitted to analysis, but nothing deleterious was found in it. Also, that other samples were sent for examination, and these were variously reported upon as severally containing 0·8gr. (approximately) per gallon, 1·12gr. per gallon, and 1·36gr. per gallon?—I suppose the analyst had not had his attention specially directed to the possible presence of arsenic.

3632. Was it the brewer's own analyst?—It was an analyst whom they employed for the purpose.

Beer suspected by consumers before cause of contamination discovered

3633. This was probably before the outbreak took place?—It was on November 7th—before the outbreak was known of in Manchester at all.

3634. (*Sir William Church.*) I suppose it was very likely sent to the public analyst of the district?—I think it was sent to a neighbouring town.

3635. It would be sent in the same manner as if a public analyst had to analyse it for adulteration?—Precisely.

3636. Not to look for poisonous contamination, but only for adulteration?—I think it was sent with a view to knowing whether there really was anything harmful in the beer; because this brewer had had complaints about the quality of his beer, and that it was doing an injury to the drinkers.

3637. (*Chairman.*) On the 7th of November some suspicion might have arisen as regards poison?—I should

think there was a suspicion in his mind when he sent the beer.

3638. As regards future safeguards, you agree, do you not, that it is most important to have something like uniformity in regard to analysis?—Most decidedly.

3639. Judging by the results of the analyses, you admit that there is considerable variety as regards the tests applied to the same sample of beer?—Not only with regard to the variety of tests, but with regard to the different methods in which different analysts manipulate the different tests.

3640. Before you can get complete security against poison you think the whole system of analysis should be uniform?—I think so.

3641. Numbers 18 and 19, you say, were brewed from all malt and hops, but were nevertheless contaminated with arsenic. You say, "very faintest trace" in each case: therefore when you say "contaminated with arsenic," were they contaminated to such an extent as by any possibility to be injurious to life?—Not being a medical man I would not like to give an opinion upon that: at the same time they were decidedly less than 1-100th of a grain per gallon.

3642. (*Sir William Church.*) Do you think that the analyst to whom this beer marked No. 12 was first sent ever examined it with a view to detecting arsenic?—I would not like to say. One does not know what method he followed in the examination of the beer. It would be presumptuous of me to say.

3643. It is rather important that we should know whether his attention was directed to it, and whether he did look for arsenic, or whether he only looked for substances which were known by former experience to be in beer, and might be prejudicial, such as Cocculus Indicus and other things which I should call adulterants rather than contaminations. I suppose you do not know what the terms of the reference to him were?—No. I think it was a sample of beer sent to him asking if there was anything deleterious in it. I have no means of knowing whether anyone at that time had any idea that arsenic was likely to be present in beer.

3644. If there was an idea that the beer had been poisoned by a servant one thing he would look for would be tartar emetic, would it not?—I should think so.

3645. So much depends upon the request made to him as to the nature of the analysis. It would be very disturbing to the public generally if a professional analyst had a sample of beer containing so much as this sent to him, and he said it contained none. But if he did not look for it it is a very different matter?—Exactly so. What was in the brewer's mind was that he knew the public were not drinking his beer. I do not know what the analyst was asked to look for.

3646. If he was asked to look for poisonous substances in the beer it seems to me that he was guilty of either a great mistake or great laxity in his examination. If he was not asked to look for poisonous substances in the beer he might have understood it only as seeing whether the beer was in a wholesome state.

3647. (*Chairman.*) You have given us a long list of samples. Do you know how many of these used Bostock's sugar? Do you differentiate between those that were using Bostock's sugar and those that were not?—I can hand in a list of those that I do know were using Bostock's sugar. I know of my own knowledge that breweries A, B, and C and D used Bostock's. With regard to F, this firm does not admit to using any brewing sugar whatever.

3648. Have you found any arsenic in any beer or other materials which you have analysed which were obtained from people disconnected with Bostock's firm altogether?—I have no further knowledge than what I have just said on this point.

3649. Numbers 18 and 19, which were brewed from all malt and hops, would be excepted, would they not?—Yes. They were brewed in a brewery which previously used Bostock's sugar in the manufacture of their beers.

3650. (*Professor Thorpe.*) I should like to ask you precisely what you mean when you say that, "To ascertain with anything like certainty the absence of arsenic from a complex organic liquid like beer by means of any of the usual tests is a matter of more than ordinary difficulty." What leads you to say that?—To take the beers I have examined: I found with Marsh's test that I could not say with any certainty that beer was free from arsenic.

3651. What do you exactly mean by the "usual tests"?—Marsh's test and Reinsch's test.

3652. But you may have to do certain preliminary operations with this "complex organic liquid" before you apply Marsh's or Reinsch's test to it?—Precisely so.

3653. Assuming that you have done that preliminary work, does it make it difficult to apply the Reinsch or the Marsh test?—To what preliminary operation do you refer in connection with the oxidation of the organic matter?

3654. The disturbing presence of preservatives?—First, with regard to the destruction of the organic matter, there is the danger of having arsenic in your acids, particularly sulphuric acid. I found very great difficulty in getting sulphuric acid free from arsenic. In the case of distilling the organic residue with hydrochloric acid there is a difficulty in getting the hydrochloric acid free from arsenic—that is with regard to getting the clean liquid to submit to Marsh's test. Again, I have found a difficulty, after the liquid has been put into the generator, in coming to a conclusion with regard to the deposit which I obtained in the Marsh-Berzelius tube. I find when I have zinc, which not uncommonly contains a large quantity of carbon, that there is sometimes a white film formed apparently of sulphur. When arsenic is present in a very minute quantity the formation of hydrogen sulphide, due to the slight reduction of sulphuric acid, causes the production of a yellow ring of arsenic sulphide instead of an arsenium mirror. These are a few of the difficulties that have occurred to me in connection with Marsh's test.

3655. Confining ourselves for the moment to beer, what is the particular difficulty in applying the ordinary methods of isolating the arsenic, say, by the agency of sulphuretted hydrogen in arsenicated beer in a form you can subsequently treat; where is the great chemical difficulty there?—The first trouble that presented itself to my mind was to operate upon a sufficient quantity of beer to get a weighable precipitate. I should hardly feel justified in attempting to weigh less than a milligramme of arsenium sulphide. Supposing the beer contained 1-20th of a grain per gallon, that would mean I should have to operate upon something like a quart of beer. After passing such a liquid as beer through all the operations necessary for the separation of that arsenium sulphide, I should have grave doubts in my mind as to the actual quantity separated, representing the original quantity of arsenic in the beer.

3656. Are these difficulties that you speak of what you yourself actually experienced, or are they set up from your inner consciousness, having set them aside in favour of Gutzeit's test, to which you eventually came?—Marsh's test is the one I have originally and always used for the examination of my sulphuric acids. In applying Marsh's test in the first instance in these beers I found very great difficulty indeed. In the first instance the test was applied to the beer itself, without any attempt to remove the organic matter, and that quite failed. With regard to the trouble with the zincs and acids, I have had an opportunity of examining a very large number; I do not know how many I have examined, but I shall be glad to give you the number should you so desire. I have only once come across zinc that is quite or almost quite arsenic free.

3657. What is the metal that you do actually now use for the generation of hydrogen in the Gutzeit test?—Zinc.

3658. You still use zinc and sulphuric acid?—Yes: but in the Gutzeit test the difficulty is got over in this way I have not to push everything to an extreme; I can eliminate the influence of the zinc and the acid by taking a given time for the reaction; that is to say, I know that a certain quantity of zinc with a certain quantity of acid in a certain time will give me a reaction due either to the acid or to the zinc. By reducing that to one-half I am able to eliminate the disturbing influence of the arsenic from the test.

3659. You mean that you are to that extent able to minimise the effect?—Yes.

3660. But surely you must know of other tests which get over your difficulties, which do not entail the use of sulphuric acid containing arsenic, or zinc containing arsenic, or any other materials containing arsenic, and which are available to you?—Yes; I may use aluminium or magnesium.

3661. But you know no methods which would enable you to get out the arsenic from the beer of a different

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order from those you have mentioned, where the chemicals you use come under no suspicion of containing arsenic? I do not apprehend exactly what is in your mind in this preliminary statement of yours, where you say that it is a matter of more than ordinary difficulty to get arsenic free from a complex organic liquid?—The large amount of organic matter to be dealt with as compared with the small amount of arsenic is what is in my mind.

3662. What I mean is that of complex or organic liquids perhaps beer is one of the simplest. It is infinitely more simple than the contents of a stomach which occasionally one has to search for arsenic?—Perhaps I ought to have laid a little more stress upon the small arsenical content of the beer.

3663. The point is that you yourself have come to the conclusion that of all tests you know of the Gutzeit test, as modified by you, is the most satisfactory?—In my hands.

3664. I believe no one has had more experience with that test than you have?—I should not like to say that.

3665. Your name, I understand, is rather identified with the present application of that test, and you are connected in the contemporary literature with that test?—Yes.

3666. The one difficulty that appears to me connected with the application of the Gutzeit test is the fact that it is not essentially a quantitative method?—That is so.

3667. You try to make it a quantitative method?—I should not like to say that I have. It has been used as a quantitative method previously.

3668. But how do you, by the application of the tests, get the numbers you have given?—I have here a set of standard colours which I have obtained showing what one gets with various quantities of arsenic, which are stated, by using a given quantity of metal—zinc—a given quantity of acid, and operating for a given time.

3669. I think we ought to be quite clear about this. What you do practically in order to produce your standard tests is to introduce definite quantities of arsenious oxide, in *this* case a one-hundredth of a milligramme, in *this* case one two-hundredth, and in *that* case one three-hundredth of a milligramme?—Yes.

3670. That you introduce in what? In a definite quantity of liquid?—Yes.

3671. And in that particular apparatus?—Yes.

3672. With a definite amount of zinc?—Yes.

3673. And a definite volume of sulphuric acid?—Yes.

3674. And then you place on this tube a piece of paper moistened with a solution of the chloride of mercury?—Yes.

3675. And you expose the gas which comes away to the action of that paper for a definite length of time?—Yes.

3676. How long?—Previously, I exposed it for a given length of time—most of these were exposed for one hour. I may mention these quantities were not obtained with this apparatus; they were obtained with tubes. That was before I devised this method of passing the gas through these bulbs. Now, however, I have come to the conclusion that it is better, instead of fixing a given time for the gas to be evolved, to take a given quantity of zinc and quantity of sufficient used acid to dissolve the whole of the zinc. In this way I am quite sure of getting a given and a comparable amount of arseniuretted hydrogen passing through the bulbs. If I am operating upon a number of substances, and I am quite sure of having a uniform sample of zinc, I think a time exposure suffices; but I find that there is a very marked difference in the zincs one obtains in the market in the rate at which they evolve hydrogen when treated with dilute acids. At the present time, therefore, I think it is better to use a given weight of zinc, and submit that to the action of a given weight or volume of sulphuric acid, and allow the gas to pass through here (indicating) until it is dissolved.

3677. May I point out to you, what no doubt you already know, that the ease with which the zinc disengages its hydrogen stands in some connection with the amount of impurity it contains?—Precisely so. The purer it is the less rapid; that is my experience.

3678. Therefore, if you use very pure materials, the purest obtainable form of zinc and the purest obtainable form of sulphuric acid which you would wish to use, the ease with which you make your arseniuretted hydrogen within a limited time—because it is a limited time—the extent of the action would be very largely modified?—That was the point of my remark which I made just now, when I said I find it is better, in view of that fact, to take a given quantity of zinc and continue the action until the whole of the zinc is dissolved. In this way I get rid of the whole of that difficulty. If I take a given weight of zinc, I must get by means of that a given volume of hydrogen, however long the action is continued. I can quite confirm what you say, that the purest forms of zinc are extremely slow to begin the reaction, and also they are extremely slow to continue it.

3679. The point about that is that there is here an element of insensitiveness in your method, it seems to me, inasmuch as it has to be prolonged in order to get the end result over a comparatively long period of time?—I find even that with a very pure sample of zinc, 7 grammes will dissolve in 3½ to 4 hours.

3680. You have to spend that amount of time before you get anything like an end result, the end result being only of a comparatively limited value, I venture to say with all submission, inasmuch as it is only a very approximate determination of the quantity, and rather tends, I think, to invalidate the test, or at all events is a disadvantage towards its general adoption, especially in view of the fact that you can get out the arsenic by other methods which do not involve the use of materials containing arsenic, and in which the end result can be obtained in a comparatively short time, and with a very much higher degree of quantitative accuracy?—That is so.

3681. You found it necessary to modify the original Gutzeit test?—Yes.

3681. And you found that on account of the disturbing influence of the sulphuretted hydrogen; is that not so?—Before I used this apparatus and before I tested the beers I removed the sulphurous acid by adding a small quantity of acid in order to dissociate any sulphurous acid that might be present in a fixed form, such as the meta bi-sulphites, and evaporating the liquid to a small quantity. I thus managed to get rid of nearly the whole of the sulphur compounds, the sulphurous action which might stain the paper. Now, however, I do not trouble to do that at all. I am able to put the beer into the apparatus and pass the gas through with the certainty that the whole of the sulphuretted hydrogen is removed in the bulbs.

2683. You place in these small bulbs a solution of the acetate of lead; then you bubble hydrogen through that, and you free that issuing hydrogen from sulphuretted hydrogen, and you hope that you do not rid it from the arseniuretted hydrogen?—I think I have to my own satisfaction settled the fact that arseniuretted hydrogen is not decomposed by passing through the lead acetate. Of course, the idea is not a novel one. I found when using Marsh's test that I could get rid of the action of the sulphuretted hydrogen upon the ring by passing the gas through the lead acetate. I have here some tubes containing arsenical mirrors; these were obtained by operating on the same quantity of arsenic; in one case the gas was passed through lead acetate solution, but in the other case it was not so treated.

3684. It is impossible to make any accurate detection of this; but what you mean is that the mirror is at least as intense as that, and that is all you can say?—Precisely so.

3685. Does it not strike you that for legal purposes, assuming that such a test as that is adopted, the very fact that it is only an approximation to a quantitative test, and that it is liable to be affected in the way I have indicated, that that rather invalidates the test for legal purposes in that it gives it an element of indefiniteness? No two persons would agree as to the exact amount of arsenic in the beer tested by that method?—I think if they were to carry out the instructions set forth in some official way there would be very little left to their judgment with regard to the colours obtainable in the end as to the presence of arsenic in the first instance. As far as my experience goes, I have had greater confidence in coming to a conclusion as to the amount of arsenic present as exhibited in the test papers than I have had from examining the mirrors seen in the Marsh-Berzelius tube, and greater confidence than I have had in examining the sublimates

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obtained from the copper in the Reinsch's test when the proportion has been small.

3686. I quite agree with what you say as to the indefiniteness of comparing mirrors in Marsh's apparatus as an index of quantity, but I venture to say that there are methods still open to us by which even in such small quantities with which we are concerned, the determination of the amount of arsenic may be made with a great degree of accuracy, either by the comparison of mirrors or by the comparison of tints, such as you have indicated?—Another difficulty that suggested itself to me in the carrying out of any test for the examination of arsenic was the quantity one has to obtain in order to carry out a gravimetric test. Of all the specimens submitted to me, I do not think any of them have exceeded a pint in volume.

3687. But there is no reason why in future you should be limited to such an amount as that is there?—No.

3688. If the public analyst demanded samples of beer he could readily obtain very much larger quantities than that, could he not?—Yes.

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3689. (*Chairman.*) I believe it is a fact, is it not, that although some of the arsenical glucose appeared at first to be of different origin, further enquiries persistently made ultimately elicited the fact that the samples which came into our hands emanated from one firm only?—That is so.

3690. You are prepared to confirm that?—Yes.

3691. I believe you wish to tell us something of the possible introduction of arsenic into foods and drinks through the medium of sulphuric acid?—Yes. The possible presence of arsenic in sulphuric acid has been recognised by medical authorities, and is given expression to in the pharmacopœias of this country for at least 50 years (A Translation of the Pharmacopœia of the Royal College of Physicians of London, 1836, by R. Phillips, last edition, 1851, p. 9). Dr. Jonathan Pereira, in his "Elements of Materia Medica" (third edition, vol. 1, 1849, p. 356), stated that "oil of vitriol which has been manufactured from iron pyrites is frequently contaminated with arsenic, mostly as arsenious acid, but sometimes in part also as arsenic acid. . . . I have seen on the sides of the bottle containing arsenical sulphuric acid a deposit of crytallised arsenious acid." In the first edition of the British Pharmacopœia (1864) and in each subsequent edition (1867, 1885, 1898) directions have been given for the testing of sulphuric acid to ensure its freedom from arsenic. That sulphuric acid may be the indirect means of poisoning by arsenic appears to be established by the prosecutions at the Marylebone Police Court, July 6th, 1900, for the presence of arsenic in effervescing sodium phosphate (Pharm. Journ. (4) XI. 51). In the evidence tendered in these two cases there was almost unanimity among the analysts that the arsenic had been introduced into the phosphate of soda in the course of manufacture from arsenical sulphuric acid. At that time I had an opportunity of examining sodium phosphate which contained half a grain of arsenium per lb., such samples as I have examined lately were arsenic free.

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(*Professor Thorpe.*) It is quite conceivable in this particular case that the arsenic may have come from the phosphorus, is it not?—Yes.

3692. What direct evidence is there that it came from sulphuric acid?—I believe no evidence was tendered to that effect.

3693. I understood you to say that the evidence was in the particular case of the druggist that was tried?—The opinion expressed by the analyst on that occasion was in the direction of it having found access to the sodium phosphate through the sulphuric acid.

3694. It might equally have come from the phosphorus itself, might it not?—Yes.

3695. (*Chairman.*) You quote some cases of the quantity of arsenious acid from pyrites, and you mention a case which appeared in the "Lancet" where the sulphuric acid incriminated contained 1·4 per cent. to 2 per cent. of arsenious acid?—Those are Professor Dixon's figures, I think. I have never met with a sample of acid which contained so large a quantity of arsenic.

3696. You draw the conclusion that the variability of the arsenic contained is so great that the only consideration which would weigh with the purchaser, I presume, for security is the analysis of the particular batch of sulphuric acid he is buying?—Yes.

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3697. You think it would be necessary to secure that it should not be tested in bulk, but that it should be tested according to each quantity as it is bought, small or great. Is that what you would urge?—Yes, and for this reason. Within the last year we had a batch of sulphuric acid. We are in the habit of testing each carboy for arsenic, and we found that half the carboys were markedly arsenical. Upon enquiry from the manufacturers we were informed that unfortunately their concentrating plant had broken down, and in order to fill our immediate requirements they had had recourse to a neighbouring manufacturer, asking him to send in a similar amount of acid, with the result that one-half of the batch was arsenical and the other half was practically non-arsenical.

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3698. (*Dr. Whitelegge.*) Since when have you been in the habit of examining sulphuric acid for arsenic?—I cannot give you the exact number of years, but somewhere between 25 and 26 years.

Precautions in obtaining acid for mineral wate manufactur

3699. That is sulphuric acid to be used in the preparation of food substances, is it?—Mineral waters.

3700. (*Professor Thorpe.*) Was that sulphuric acid supplied under a guarantee of purity?—We had no guarantee except in so far as they knew that we must have it arsenic free. That is a matter of knowledge between ourselves. I can, but not for publication, give you the name of the firm with whom we deal. We were informed that in consequence of the price of the acid being diminished it was necessary that they should have recourse to using iron pyrites for the manufacture of their acid. Upon receiving that information we took the best means we could of protecting ourselves by not only asking them to send it de-arsenicated, but at the same time testing it ourselves.

No arsenic found in barley grown on arsenical soil.

3701. (*Chairman.*) I believe you have had an opportunity of examining a sample of barley. You say that you have found traces of arsenic in malt. I suppose you have succeeded in finding them yourself?—Yes. I had the opportunity of examining a sample of barley reaped in 1900. The seed was sown in chalk soil in April, and the land was treated the previous March with 2cwt. of raw bones and 2cwt. of superphosphate (arsenical) per acre. I did not succeed in obtaining the slightest indication of arsenic.

3702. Are you inclined to contend from that that it would not be dangerous to largely manure land with superphosphate or other artificial manures which are impregnated with arsenic?—I should not like to say that it was absolutely not dangerous, neither should I like to assert the contrary.

3703. But in this particular instance you found none?—None.

Chemical substances liable to contain arsenic.

3704. What substances may arsenic be present in?—In addition to other substances, arsenic may be in acetic acid, phosphoric acid and phosphates, tartaric acid and the many articles into which it enters, such as baking powders, aniline dyes, which are not uncommonly used for colouring confectionery of various kinds, as well as cheap wines, purgative salts made from Epsom salts, sodium sulphate in pickles and sauces, and in caramel and similar substances. There would seem to be very great difficulty in the way of ensuring the absolute freedom of these various articles from some traces of arsenic.

Arsenic in sodium sulphate and caramel.

3705. (*Professor Thorpe.*) Have you yourself analysed any of these substances?—Sodium sulphate I have found commonly contains small quantities of arsenic. It is chiefly obtained in the manufacture of mineral waters. The residual arsenic is left in the sodium sulphate which is taken from the generators. I have also found arsenic in caramel. I should like an opportunity in the future to speak of some other substances, particularly caramel, as I have one sample in particular in mind which contained a fair quantity of arsenic, but not nearly so great as in the glucose which I have examined.

3706. Have you found arsenic in baking powders?—No.

3707. In artificially made Epsom salts?—I have not.

3709. Have you found it in any pickles or sauces?—No, I have not.

3709. (*Chairman.*) You indicate here a possibility of a danger rather than a danger which you have yourself proved?—That is so.

3710 You think a danger really lurks in the consumption or use of these articles which may enter into food?—Yes.

3711. I suppose you wish us to understand, to sum up your evidence, that you think most constant and careful analyses of sulphuric acid are the only protection as regards the consumer, whether of beer or articles of food?—From my own experience I think that it is absolutely necessary.

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System of testing sulphuric acid at Messrs. Jewsbury and Brown's.

3712. What degree of purity of sulphuric acid do you think is suitable for the manufacture of foods and drinks?—At Messrs. Jewsbury and Brown's works large quantities of sulphuric acid are used for the production of carbonic acid gas (CO_2) for the aeration of the mineral waters. Between 20 and 30 years ago the practice of testing every carboy of sulphuric acid for arsenic was adopted because of the increasing use of pyrites in its manufacture. Although only de-arsenicated sulphuric acid is bought, it is necessary to rigorously persevere in the testing because of the liability to accidents, such as, for instance, the breakdown of the acid maker's plant. It should be pointed out that in the use of the sulphuric acid for the production of the carbonic acid gas the acid itself does not enter into the composition of the mineral waters, neither can any of its non-gaseous impurities do so. Notwithstanding this fact, in order to guard against likely and unlikely accidents, we prefer to have no poisonous article on the premises. In order to give an idea of the amount of control which this system of testing ensures, I have compiled a table of our records for the last four years, and taken two other years at four year intervals. This table expresses in percentages the amount of acid rejected on account of its arsenical content. For obvious trade reasons the actual quantities bought and rejected are not given:—

TABLE.—Proportion of Sulphuric Acid rejected on account of its Arsenical content.

Year.	Rejected per cent.	Remarks.
1888	0·46	
1892	Nil	
1896	"	
1897	"	
1898	"	
1899	0·15	
1900	0·88	Half of this quantity was in one batch, the batch I have referred to.

The sulphuric acid which is used in this process is not absolutely arsenic free; such an article is almost, if not quite, unobtainable; but we do succeed in obtaining at a reasonable price an acid containing from one part in 1½ millions (1,500,000) to one part in 2 millions (2,000,000); occasionally we obtain it containing as little as one-tenth of this proportion. I may say that it is extremely pure acid which we only rarely come across.

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3713. (*Professor Thorpe.*) Do Messrs. Jewsbury and Brown contemplate using liquid carbonic acid?—They have had the matter under consideration.

3714. What is the difficulty?—The difficulty is one of cost.

3715. Is it cheaper to make your carbonic acid for the aeration of your waters still from carbonate of lime or soda?—It is cheaper to make it from carbonate of soda.

3716. Are there any brewers in the neighbourhood making liquid carbonic acid?—I do not know of any. In Manchester we have a depôt of the Lea Bridge works which supplies large quantities, I believe, to the local manufacturers.

3717. You have no experience yourself of the use of liquid carbonic acid?—We use it in special circumstances.

3718. You say the cost is prohibitive at present?—It is simply a trade matter. We simply use it for convenience with certain machines.

3719. Anyhow, in future one way of getting rid of arsenic would be to use natural liquid carbonic acid?—I do not see any possibility of arsenic getting into liquid carbonic acid gas.

3720. You would avoid the use of arsenicated sulphuric acid in your works?—Yes, precisely.

EIGHTH DAY

AT THE TOWN HALL, MANCHESTER.

Tuesday, 26th March, 1901.

PRESENT:

SIR WILLIAM CHURCH (in the Chair).

Professor THORPE. | Dr. WHITELEGGE.

Dr. BUCHANAN, Secretary.

Dr. J. DIXON MANN, called; and Examined.

Dr. J. D. Mann.
26 Mar. 1901.

3721. (*Chairman.*) I believe you are Professor of Medical Jurisprudence and Toxicology at Owens College?—I am.

3722. During the recent epidemic you saw a number of cases in both in-patients and out-patients in the Salford Hospital?—I did. Might I add this—it will facilitate matters with regard to the clinical aspect—that I am physician of the Salford Royal Hospital, which gives me a good opportunity of seeing those cases.

3723. I believe you also saw cases in private practice?—Yes, in consultation.

3724. Many?—No. I would not like to say many—several.

3725. As compared with the hospital cases, were they severe?—Yes, they were, because being seen in consultation they were necessarily severe. As a rule I saw them at their own houses, not at my rooms.

3726. And they presented the same symptoms?—Yes, they practically presented the same symptoms; that is to say, they were varied. In one or two of the private cases they were rather anomalous, as it happened, but that is a mere accident.

Dr. J. D. Mann.
26 Mar. 1901.

3727. I suppose they were the neuritic symptoms for which you were called in consultation chiefly?—In two or three instances. In the others it was on account of the anomalous nature of the case, the doctor not being able to diagnose what it was.

Pigmentation not very common in Salford hospital cases.

3728. Were the private cases pigmented in the same way as so many of the hospital patients were?—No. My fortune has been rather curious in respect to the pigmentation. Although Salford is a centre where one of the large breweries to which is attributed a good deal of this beer is situated, and where a large number of the people drank this beer, the cases of pigmentation in the Salford Hospital, according to my experience, were exceedingly few in proportion to the total number of cases.

Gastro-intestinal symptoms.

3729. Were the gastro-intestinal symptoms marked?—In a few instances. In one private case, for instance, where the man had for a week before being laid up symptoms of acute arsenical poisoning, vomiting, and purging. He got better from that, and afterwards

developed one of the most severe acute attacks of neuritis I have seen.

3730. Had you any doubt in your own mind that these cases were due to arsenical poisoning?—Not the least.

3731. What evidence did you get of the presence of arsenic in these patients during life?—There are what I term the immediate channels of elimination, the urine and the fæces, and then the secondary channels, the skin and its appendages. First of all with regard to the urine, I found arsenic present in the urine in all the recent suspected cases that I had to do with. Arsenic was found in the urine 21 days, in another case 32 days, and the longest period in which I found it was 59 days after the patient had ceased drinking beer. That was from 40 ounces of urine; but I look upon it as rather exceptional. I had found arsenic in this case before, and I was purposely leaving it for a very long time in order to see how long I could find it. I may say, in order to prevent any misunderstanding, that the cases that I quote as regards the urine, are cases that I had under my own care in the hospital wards, and, consequently, that is the minimum time; of course patients would probably say that they did not take beer for so long before, but I do not reckon that in. I reckon it from the day of admission into the hospital, when they could not have had any beer.

3732. I thought it might have exceeded that?—Yes, it is quite possible, by an unknown time; but I do not attach any importance to that, because everybody knows the unreliability of evidence of people given in matters of this kind.

3733. With regard to the amount, was it traceable or appreciable?—Very appreciable. In fact, if one had gone to the trouble, and had taken, say, a couple of litres, one could have got a weighable amount. In many of the cases, of course, it depended a great deal upon how long the patient had been abstaining from beer. I got a lot from the out-patients, for instance. There I had to take their word for it, and many of them frankly avowed that they had been taking beer up to that day, and in those cases one found an enormously, if I may use the term, large quantity. There was no difficulty at all. Reinsch's test in a very few minutes brought down a copious deposit on the copper, from which I obtained a large crop of crystals.

3734. You mentioned fæces. Will you tell us your experience with regard to that?—I have examined the fæces frequently for experimental purposes before this epidemic, but I have not examined them in this epidemic, because I knew exactly what occurred, and it is rather a disagreeable and troublesome process. Some 10 or 12 years ago I made a number of experimental observations both on the fæces and urine in people who were taking arsenic, and I found that one could detect it very easily. For example, in a patient whose urine and fæces showed no arsenic, as proved by analysis, on giving five drops of liquor arsenicalis equal to one-twentieth of a grain of arsenious oxide, half-an-hour afterwards arsenic was easily detected by Reinsch's test in the urine, and also in the first subsequent motion. I have proved this several times, so it was unnecessary to do it again. I assumed that the arsenic was being eliminated by the bowels as well as the urine.

3735. *(Dr. Whitelegge.)* Where were those observations published?—I quote the fact in my book, but I have not published it separately, because it was a pretty well-known thing. It was merely refining it down. It was known that arsenic would pass by the urine pretty quickly, and I did it simply as a proof test. Perhaps I may presently come back to the point. I next took some of the horny scales that you find on the feet in keratosis, which is very common, as you are aware, in chronic arsenical poisoning. I must confess that I was astounded with the amount of arsenic which was present in the horny scales, and also in the other skin appendages, the hair, and particularly the nails. I jotted down a few notes that I made in a number of cases. For instance, I got ample evidence of the presence of arsenic from 0·2 gramme of the horny scales, and 0·1 gramme of the horny scales, and even from ·03 gramme, that is three centigrammes of the horny scales. I imagined I might find it with difficulty, but in fact I obtained well-marked crystals without any difficulty whatever. Further, it is of interest to note that some of the arsenic present in these scales is, to a certain extent, soluble in water, for on boiling one-tenth of a gramme of the scales for about three minutes in 20 or so cubic centimetres or distilled water, and then filtering through very close filter paper so as to keep back any particles, I got evidence of arsenic both from the filtrate and from the solid matter. I did this several times. Then, in two instances, I obtained arsenic from the sweat. Unfortunately there were not many opportunities of making experiments, because hyperidrosis is one of the early symptoms, and I had difficulty in obtaining enough fluid to enable me to make an examination. The next point is the nails. I was more surprised than ever with the amount of arsenic that was present. For instance, I obtained from one-tenth of a gramme, five centigrammes, eight centigrammes, six centigrammes, and three centigrammes, of the nails, in each instance, arsenic crystals without any difficulty. It was quite obvious that there must have been a large percentage present. Some of these cases had gone on for a long time, but I had to take the patient's word for it. With regard to some of them I felt fairly satisfied that they were telling me the truth, but with regard to others I had doubts. In one case I got arsenic out of five centigrammes of nail cuttings from an out-patient, a man, who said he had had no beer for four months. I was disposed to believe him, because he had been in the Union Hospital as a patient for neuritis, and would not have had any opportunity of getting beer. I also examined some of his urine when he came in, and I found no arsenic. If he had been taking beer more recently I should have found it in the urine.

Arsenic in sweat.

3736. I suppose when the arsenic gets into the epithelial structures it would be likely to remain there until they were shed, because it is extra vascular?—Yes; it is outside the system entirely.

3737. Once there it would remain there until in the process of time the epithelial layers were worn off?—Yes; whereas any arsenic that is present in the urine is directly derived from the body. In amounts of hair varying from a gramme to half a gramme, three-tenths of a gramme and even in two-tenths of a gramme, I found arsenic. These investigations in several ways are interesting. In one or two cases I found arsenic present in the hair, and in the nails, and there was absolutely no symptom, and had been none. In the surgical wards, for instance, there was one case of a woman admitted for a fractured leg. One of my colleagues knew that I was investigating these matters, and he said, "There looks a likely subject for you upstairs," so I went into the ward; but the woman denied having had any symptoms whatever, any tingling or numbness. There was no pigmentation nor keratosis; absolutely no symptoms. She was simply in the hospital for a surgical accident. She was an obvious alcoholic, with a large liver, so I got the sister of the ward to cut some hair off and clip the nails, and in both of these I found arsenic in the usual quantities. That is not a solitary case; so that you may have arsenic taken in beer without producing any apparent symptoms in certain cases. I was particularly struck with the affinity of these keratin tissues, the horny layer of the epithelium, the hair, and the nails for arsenic, and the large amount that they would take up. I turned it over in my mind whether any deduction could be drawn from that, and I thought of the neuro-keratin which is in the nerve structures, in the sheath of the nerves, and also in the brain. Neuro-keratin has such a very close chemical relationship to ordinary keratin that I thought it was possible it might have the same affinity for arsenic that the keratin itself undoubtedly possesses. I believe that although Gautier and many other observers have said that arsenic has been found in skin, nails, and hair, no one has pointed out, as far as I know, the extraordinary affinity that exists between the keratin tissues and arsenic. This seemed to me to offer a possible explanation of the nerve symptoms. I had not the opportunity until quite recently of carrying out an experiment that I wished to make, but recently I have done so; but I have not finished the investigation, so I should like what I say to be taken as a provisional inference, and not as a decisive conclusion. Physiological chemists have found that neuro-keratin exists in the white matter of the brain in about ten times the amount that it does in the grey matter, that is to say, in the grey matter you get 0·3 per cent. and in the white matter you get, according to some observers, fully 3, and according to other observers, just under 3 per cent., so that it is just ten times the amount of the other. It struck me that if I took a brain, and separated the grey matter from the white, and analysed equal weights of each, I might possibly get some evi-

Arsenic in hair of alcoholic patient without symptoms of arsenical poisoning.

Affinity of keratin tissues for arsenic.

Arsenic in grey and white matter in brain.

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dence as to whether the neuro-keratin did take up the arsenic. Dr. Reynolds was good enough to furnish me with a brain of one of his cases in which a post mortem had been made for arsenical poisoning. I first of all divided it longitudinally as nearly as possible into halves. In one half I separated the grey from the white matter. Of course, it was impossible to do so absolutely. I got two heaps; one consisted chiefly of white, and the other of grey matter; that is as much as I could say. I took 240 grammes of each; the other half of the brain weighed 660 grammes, and it was dealt with just as it was, without any separation. From the grey substance of 240 grammes I got an unweighable quantity of arsenic. From the equal amount of 240 grammes of the white matter I got the equivalent of 1-80th of a grain of arsenious oxide, and from the complete half I got about 1-30th of a grain of arsenious oxide.

3738. (*Chairman.*) Have you taken any of the peripheral nerves and tried them?—No. I had no opportunity. Of course I am at the mercy of the post-mortem makers, and I have had to make special appeals to get what I have had.

3739. You speak of other means of extraction. Besides the urine, scales, excretion and sweat, you have mentioned the hair and the nails. Are there any others?—Those are all the sources of elimination that I have investigated in the living.

3740. You did not make any experiment upon the mucus from the lung?—No. There are plenty of cases where you have bronchitis associated with arsenical symptoms, and I might have got some mucus, but I did not think of it.

Arsenic in hair.

3741. (*Dr. Whitelegge.*) In cases of long hair would you expect to find arsenic some years after?—I am doubtful about that. There might be. With regard to the elimination of arsenic I should say that as regards urine the elimination begins very quickly, very promptly, and, as far as I know, is continuous under ordinary circumstances, so that arsenic is not stored up in the system as some of the heavy metals like lead and copper are. The tendency seems to me, from what I have observed in this outbreak, to be that the arsenic in a comparatively limited time all gets away excepting very small traces, which may be found post mortem. Therefore, the hair, I take it, would become free in time. I got arsenic from some hair from an out-patient, who said that he had not had any beer for five months, but I should imagine that in six or eight months most of the arsenic would have gone away.

3742. Gone away in the sense of having gone into the hair?—Yes, it would probably have gone into the hair.

3743. I am speaking of the case of long hair?—That depends upon the length of time. You would find it at the extreme end, if the hair was very long. If it was not cut you would find it for an indefinite time. If it was once there, and if it came away, it would be simply by attrition. I suppose that if you cut the hair off it would retain the arsenic for an indefinite time, in the same way as you can keep arsenic in a bottle.

3744. In the case of long-haired women you would find traces of old arsenical poisoning?—Undoubtedly.

Difference between chronic and acute arsenical poisoning. Cumulative effect greater in the former.

3745. But no time-equation has been attempted in that way?—Not that I know of. In England chronic arsenical poisoning as in the present outbreak is quite a new matter. A great distinction must be drawn between cases of acute arsenical poisoning which were previously known in this country and these cases of chronic arsenical poisoning; for example, in the acute arsenical poisoning you will not find arsenic in the urine longer than 10, 12, or 14 days at the outside. I have never found it in acute cases longer than five or six days. It seems to me that the constant taking of small doses causes the arsenic to back up, if I may use the expression, in the tissues. I do not think that it combines in the sense that the other metals do, but more is received than can be eliminated. A certain amount is stored up, and it takes time to come away. The general tendency is for the arsenic to get away, judging from the cases I have followed so far, in six or more months probably, but something like that. That is a rough guess. I should like to point out to the Commission there is a very thick line to be drawn between acute arsenical poisoning and chronic arsenical poisoning, so far as the elimination goes. We have always regarded arsenic as a non-cumulative poison up to now. Cumulative is a relative term, but arsenic lingers in the system much longer than we thought.

3746. If the question should arise whether three or four years ago there was arsenical poisoning unnoticed going on in Manchester or anywhere else, it would be conceivable, would it not, that some trace of it might be found in the case of long hair?—Yes; only I think probably the hair would be cut at intervals during that long period, and the traces of arsenical poisoning might disappear. In one case I made an experiment on a woman in whom I had watched the arsenic being gradually eliminated and disappearing. I took as much as I could off the tips of the long back hairs, and I also took some close up to the scalp. In the long hair at the back I found arsenic easily, but in the other I could not quite satisfy myself whether there was any arsenic or not. It had just got to about vanishing point.

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3747. (*Chairman.*) Did you by any chance make any experiments with hair from different parts of the body?—I did not.

3748. Pigmentation is particularly marked on certain parts of the body, and the pubic hair particularly might contain a larger quantity than hair from the head, as pigmentation is more marked on the pubes than on the head?—It is quite possible; but I have made no observations in that direction. The hair I obtained was exclusively from the head.

3749. Did you make any control observations when giving patients arsenic medicinally?—Yes; I did that long before this epidemic.

Cases without pigment frequen

3750. You have already told us that in your cases pigmentation was not a marked feature?—That was so.

3751. And you have also told us that the peripheral neuritis was well marked in many cases in which there was no exceptional pigmentation?—Quite so.

Cardiac sympto

3752. I think you noticed something in connection with the condition of the heart in those patients?—Yes; there was a very marked tendency to rapid cardiac dilatation, such as we usually associate with alcohol. It is a very difficult matter to draw the line, seeing that the arsenic was in alcohol. At first I approached the question with the impression that the cardiac symptoms would be due to alcohol, but I gradually came to the conclusion that the arsenic had a very great deal to do with it. After listening to the evidence at the inquests, and in attending my own cases at the hospital, and hearing of others which were reported to me by medical men, I have come to the conclusion that in the great majority of cases death was due to cardiac failure. There were other associated symptoms, such as bronchitis and enlarged liver, which might be due to the cardiac dilatation.

3753. Which side of the heart was especially dilated?—The left side—the left ventricle. This came on with exceeding rapidity in some cases. The patient would have a normal temperature and present normal appearances very frequently, with some intercurrent condition, such as bronchitis or broncho pneumonia, and would be going on pretty much as usual, when suddenly in a few hours the temperature would drop to sub-normal, and the patient would evidently be in a state of absolute collapse. You could not find any apex beat; the area of cardiac dulness would be very much enlarged, and the patient would rapidly sink, the heart never recovering. I saw several deaths of that kind. I was very much impressed with the effect that the arsenic seemed to produce upon the heart muscle. I may say that in the analyses I made I found, as would be expected, a very large amount of fat both in the liver and the other organs. Of course, one associates that with alcohol. The organs had undergone a considerable amount of fatty change. This possibly may have had to do partly with the rapid cardiac dilatation. On the other hand there is the question of the innervation of the heart, the nerve supply to consider. From the suddenness of the occurrence, I think it is more likely to be due principally to some interference with the nerve supply caused by neuritis, the same as you have in peripheral neuritis.

Deaths on heart failure

3754. That we are acquainted with. It takes place in other forms of neuritis—diphtheritic neuritis, for instance—does it not?—Quite so. It is analogous to that. In diphtheritic sometimes you got absolutely sudden death; whereas in these cases they were sudden in the sense that the patient being in a fairly favourable condition, considering the disease, until a given day, when within six, eight, ten, or more hours the patient would die in a state of collapse. If you saw the patient during that time you would find evidence of rapid cardiac dilitation.

3755. In those cases of rapid cardiac dilatation had the muscular fibres undergone fatty degeneration, or did you find rather that the heart was in a state of fatty infiltration?—I cannot say that I went into that. That is rather histological. I did not examine microscopically. I had not the time.

3756. You would say, would you not, that the heart of many habitual exceeders in alcohol is in a state rather of fatty infiltration than of fatty degeneration?—Quite so.

3757. This would, if it was due to fatty degeneration of the heart, degeneration of the muscular tissue, itself point a little to its being due to something in alcohol?—Quite so; I am not speaking of that, merely that there was a large quantity of fat present.

3758. In those cases in which death appeared to be due primarily from the heart, did you notice the condition of the diaphragm?—Yes, in two instances. In one case of my own in the hospital the diaphragm was paralysed for fully a week before death, and the respiration was all costal.

3759. That you would attribute, of course, to the condition of the nerves rather than to the muscular tissues?—Yes. I trust I made myself clear with regard to the heart. I put the fatty change in a secondary position, although I mentioned it first. The interference with innervation I think is the more important cause.

3760. (*Dr. Whitelegge.*) Do you attribute that to the arsenic?—I do. I must repeat that it is very difficult to distinguish between some of the effects of arsenic and of alcohol. We have found the same thing with alcohol, so that it would not be proper for me to make a very decided statement. I should not be justified in doing so.

3761. Have you found anything parallel in your observations with regard to the action of arsenic on the heart?—I should like to make it clear to the Commission that our knowledge of chronic arsenical poisoning before this epidemic has been practically *nil*. I take it that the most experienced of us have only seen the fringes of it—those few cases which have occurred through the over-administration of medicine, through idiosyncracy, or some of those cases where people have been poisoned by wall-paper, and so forth. It has been a very exceptional thing. Most of our knowledge of arsenical poisoning in England up to the present time has been of acute cases.

3762. In those cases has there been anything to observe to suggest this particular complication?—I had not observed it myself. I had no experience to go upon in the matter before this epidemic. I should not like to express an opinion upon it.

3763. (*Chairman.*) Without expressing an opinion, they were very anomalous symptoms, were they not, which were observed in connection with arsenical poisoning from wall-papers?—Yes; but it so happens that I have never personally had to investigate any of those cases.

3764. And neuritis occurred?—Yes; I have read of symptoms of neuritis occurring.

3765. And extreme feebleness of the pulse has been noticed in connection with it?—Possibly; but I cannot speak as to that.

3766. Do you think that it is likely that we have for long confounded and called the condition alcoholic neuritis which might really be due to unrecognised arsenical poisoning?—It is a very difficult question to answer. I believe still that there is such a thing as alcoholic neuritis, but I may say I have latterly been disposed to think it quite possible that there have been small quantities of arsenic in the beer—I say quite possible, I do not go beyond that—which would account for some of the neuritis we have had in these parts before this epidemic. It was a fairly common thing in hospital work to have cases of neuritis before this epidemic. Of course, one put it down to alcohol, all these people being drinkers, but since this epidemic I have had my doubts as to whether arsenic may not have had something to do with it. I say that, of course, without at all ignoring alcoholic neuritis, which I firmly believe in.

3767. It seems to have been very much more common in this district, in Manchester and Liverpool, than it is in London and the southern large towns?—So I believe. I have heard your own experience at St. Bartholomew's.

3768. You cannot say anything of your own knowledge with regard to that?—I cannot.

3769. (*Dr. Whitelegge.*) Do you associate alcoholic neuritis with beer or spirit drinkers?—I am entirely relying for my evidence upon spirit drinkers, because if the people took beer there might be arsenic in it. You assume, however, that there is not arsenic in alcohol—that is to say, in spirit. On going over the evidence very carefully, I have found several cases in which the patient took spirits exclusively, and suffered from neuritis.

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3770. (*Professor Thorpe.*) Was that in Manchester?—Yes.

3771. (*Chairman.*) You are aware, no doubt, that when the so-called alcoholic neuritis was first discovered, or, at all events, first described by Sir Samuel Wilkes, that he thought he was dealing with spirit drinkers?—Quite so; that was my first impression. When I first came across alcoholic neuritis I thought it could not be produced by beer, that there was not enough alcohol present. I think that was the impression of almost all of us at first.

Alcoholic neuritis in a non-beer drinker.

3772. Have you seen any recent cases of alcoholic neuritis among persons who apparently have not drunk suspected beer?—I have recently seen a case of alcoholic neuritis in which the person drank no beer at all. This was an elderly lady, whose husband told me, and I know from internal evidence that there was no reason to deceive, that she had only drank whisky, as beer did not agree with her. She had had no beer for 14 or 15 years, but she had undoubted neuritis. That is one of the cases which makes me feel satisfied that there is such a thing as alcoholic neuritis.

3773. Under what heads would fatal cases be likely to be returned in death certificates?—As alcoholism particularly.

3774. I believe alcoholic neuritis is a term which has not been used by the Registrar-General; it has all gone under the head of alcoholism, has it not?—I have not looked into the reports.

3775. Then you would not like to give us an opinion as to how long the profession generally has recognised alcoholic neuritis to put it on death certificates?—As to absolutely putting it on death certificates, I could not say from my own knowledge, but from my acquaintance with professional opinion, for a long time—a dozen or more years—we have looked upon alcoholic neuritis as an ordinary complaint—that is to say, as a complaint which occurred with a certain degree of frequency.

3776. Do you say that for more than a dozen years it has been in the nomenclature of disease?—We have associated this condition with alcohol more closely perhaps than has been the case further south. The late Dr. Ross was one of the medical men here who gave a great deal of time to the question and wrote a good deal about it, and in that way the profession in the neighbourhood got acquainted with it early on, so to speak. But I cannot speak to the actual form of the certificates.

Death from other causes accelerated by arsenic poisoning.

3777. Do you know any instance where arsenical poisoning through beer seems to have accelerated death without causing distinct neuritic symptoms?—Yes. I have known several cases in which there was some dormant, at least some chronic malignant disease, in which the patients died unexpectedly, and in which there were no arsenical symptoms. I have found arsenic during life from some of the excretions in these cases, and I have found it in the viscera after death. My impression was that, although the malignant disease was the main cause of death, death was undoubtedly accelerated by the arsenic, and there is equally no doubt that death has been accelerated in acute cases of bronchitis and pulmonary trouble generally, as, of course, you would easily perceive from the heart.

3778. (*Dr. Whitelegge.*) Would arsenic be mentioned on the death certificate in such a case?—No; that would involve an inquest.

3779. (*Chairman.*) Do you think it had a prejudicial effect on the cases in connection with malignant disease?—I think so, from the mode in which they died. They collapsed in an unexpected way as compared with ordinary cases of malignant disease. Oddly enough, in other cases there is an increase in the temperature which is not common in abdominal malignant disease.

3780. On the other hand, arsenic has been supposed in some forms of, say, new growth, rather than malignant disease, to hold it in check?—That is so.

3781. So that those cases ought to have improved?—They ought to, but, unfortunately, they did not. That was also a striking thing as regards the anomalous

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poisoning. I have seen cases where there were no symptoms of neuritis, no pigmentation, but there was a rise in the temperature, and the patient had a kind of febrile attack. There was the presence of arsenic in the excretions, and there was no recognisable disease. The condition was mistaken sometimes for enterica, but there were no enteric symptoms. The patients continued for a fortnight or three weeks with an elevated temperature, and then slowly recovered—very slowly. Similar cases, I believe, have been recorded at Hyères during the epidemic.

Febrile attacks resembling enteric fever in some cases.

Arsenic in viscera of fatal cases at Manchester.

3782. Did you examine any of the viscera in these fatal cases?—Yes, I examined parts of the viscera from 11 cases, but in one or two of them there were only parts, such as brain and bones. That was for scientific purposes. I have examined six bodies for the coroners of Manchester and Salford.

3783. Will you give us the results?—The first two cases I am going to mention are valuable because the patients died in the Crumpsall Hospital, and therefore they were under observation for a time. One case was that of a woman aged 40. She was admitted in the Crumpsall Hospital on October 30th, 1900, and died on November 22nd. She was, therefore, in the hospital for 23 days. In that body, neither in the liver, kidneys, or spleen, nor in about eight fluid ounces of liquid from the abdominal cavity—she had ascites—did I find any arsenic. That result was corroborated by Dr. Stevenson, whose evidence you have already had, and who had the corresponding half of the viscera. The next case was that of a woman whose age I do not know, though it can be ascertained, as it was one of the Manchester Coroner's cases. She was admitted on the 2nd October, 1900, and died on the 23rd November. She was, therefore, in the hospital for 52 days, obviously without beer. I asked Major Balentine whether there was any chance of her getting beer, but he scouted the idea, and said that, of course, there was no chance of her getting any. In that case I found arsenic present in 16½oz. of liver, but not in a weighable quantity. In 4½oz. of kidney I also found arsenic present, but not in a weighable quantity. In 2½oz. of spleen I found a trace of arsenic. With the exception of another case, one of my own, these are the only two cases I can vouch for as to the length of time which elapsed since their taking beer before death. The others are outside cases—coroners' cases—in which the evidence given is probably untrustworthy. The next case was that of a woman aged 38, who died on December 2nd. In 31½oz. of liver arsenic was present, but unweighable. In 2¼ozs. of kidney arsenic was present, but unweighable. In 3⅝oz. of spleen there was an obvious trace. In 6⅜oz. of heart there was a trace; and in 3½oz. of lung a faint trace. The next case was that of a woman whose age I do not know. It was a coroner's case, and the age could therefore be obtained. She died on December 24th. In 19½oz. of liver arsenic was present, but unweighable; in 3⅞oz. of kidney arsenic was present, but unweighable; and in 2¼oz. of spleen arsenic was present, but unweighable. I may say that all these cases were women with one exception. I have only examined one male case out of all this number. The next case died on November 27th. Unfortunately but a small amount of the viscera was sent, and I had to divide it with Dr. Stevenson. I only got 8oz. of liver, but in that 8oz. of liver I found a weighable quantity of arsenic, over 2-10 of a milligramme. Reckoning the size of the liver, that would make 1-30th of a grain of arsenious oxide in the whole organ. Dr. Stevenson practically came to the same conclusion. In 1½ozs. of kidney there was an unweighable quantity; in 2oz. of spleen there was also an unweighable quantity; and in 1¼oz. of brain there was barely a trace. I would not like to say there was not any—there was just a little deposit. The next case was also that of a woman, who died on the 11th December. I do not know her age. In 20oz. of liver there was 8-10 of a milligramme of arsenic, equal to about 1-25th of a grain of arsenious oxide for the whole organ. In 3⅝oz. of kidney there was an unweighable amount; in 1½oz. of spleen there was also an unweighable amount; and in 2oz. of stomach there was just a faint trace. These are cases which I have investigated for my own information. The other case was that of a male who died in February. I do not know the date of the death, nor do I know the age. In this case there was in the liver an amount equal to 1-18th of a grain of arsenious oxide. The kidney and the spleen I have not yet examined, as I have not had time. I examined the bodies of the vertebræ. I had 100 grammes of liver, and I found arsenic in an unweighable amount. In 75 grammes of brain I found a mere trace. Then there is a case which is of some interest—it was my own case in the hospital. During life I found arsenic present in the hair, but not in the nails. There was no keratosis, but I found arsenic in the extreme ends of the hair, though I found scarcely any in hair taken from close to the head. After death we got all the organs to make a complete examination, so that this case is interesting from a scientific standpoint. I found in the liver, which weighed 1,012 grammes, simply an appreciable, but an unweighable amount. In the kidney, which weighed 157 grammes, I found a trace; in the spleen, which weighed 72 grammes, I found a slight trace; in the brain, which weighed 1,184 grammes, an obvious trace; in the bodies of the vertebræ, which weighed 130 grammes, I found an obvious trace, very comparable with that obtained from the whole of the brain. I had the thyroid very carefully taken out and freed from everything else. It weighed 15 grammes. In that I only found a faint trace of arsenic, such as I should expect to find from a similar weight of muscle. You will understand the point of that. Finally, there was one other case in which I examined 7½ozs. of viscera, liver, kidney, and spleen, sent to me by the coroner. I had to analyse them together, and I found equal to ½ milligramme of arsenious oxide. In one more case I examined the vertebræ. I have some more bones, which I am working at still. In 200 grammes of the bodies of the vertebræ there was an appreciable but unweighable amount. That is rather important scientifically. I might also mention, as interesting from a medicinal standpoint, that the bodies of the vertebræ when I sawed them down before breaking them up into small pieces exhibited an extraordinary amount of red marrow, such as I have never before seen. There was the same appearance in the bones of the skull.

3784. Have you made any examination of the blood?—No; I have not had any blood.

3785. You do not know whether there has been a large quantity of myeloid cells?—I cannot say; but that would point to the influence of arsenic in anæmia and dysentery.

3786. The result of all these examinations of what we may call chronic cases is that you have been able to find in the viscera very much smaller quantities than you would expect to find in fatal cases of acute arsenical poisoning?—Undoubtedly.

3787. Have you any knowledge of detecting arsenic in bodies in whom there has been no suspicion of the ingestion of arsenic?—Not in the bodies. I found it, unfortunately too late, in one case, in a very early part of the epidemic, where I got some keratosis.

3788. I am not speaking of the epidemic alone, but whether you have found in the course of your toxicological experience arsenic frequently or ever present in the viscera where there has been no likelihood of arsenic having been ingested?—I cannot say that I have ever examined for it.

3789. It has been stated that arsenic is a normal constituent of the tissue?—You are alluding to Gautier. I entirely disagree with that. I believe it was introduced adventitiously, and that it is not a normal physiological constituent of the body. You might just as well say that copper is, and with some reason, for I have never examined the viscera of a body, particularly the fæcas of a presumably healthy person, without finding traces of copper; yet copper is not a physiological constituent of the body.

3790. Would you like to make any statement as to any new facts which are suggested by the results of these investigations into the cumulative effect of arsenic?—Yes; that it has changed my views with regard to the cumulative effect—again reserving the word "cumulative" as being a relative term—that arsenic does remain much longer in the tissues of the body than I thought it possibly could.

3791. It comes rather to this, that the body is only capable of excreting a certain quantity of arsenic in a certain length of time?—Yes. Perhaps you will allow me to refer to the second case again. The woman was in hospital for 52 days, and yet arsenic was found to be present in the tissues. You cannot assume that she had taken that much more than the woman who had only been in hospital for 23 days, and in whom no arsenic was found. It was a typical case, according to Dr. Reynolds. There was pigmentation and all other

symptoms. The only assumption is that there must have been some defect in the elimination as you have suggested where the tissues undergo such changes, and the vitality is so low that arsenic is eliminated very slowly indeed, and takes a long time. In the case of more vigorous persons it is got rid of much more quickly. In case of chronic poisoning the arsenic lingers in the tissues very much longer than I had any idea of, from my previous knowledge of acute cases and administering it medicinally for a moderately prolonged period.

3792. Have you any views with regard to the channels other than the urine by which arsenic may be eliminated?—Only those I have named.

3793. Would that throw any light on the fact that women seem to have suffered fatally much more frequently than men?—I think it is probably want of activity. I regard it simply as a question of elimination; many of these women were chronic alcoholics of the stout variety, who get very lethargic and do not move about nor go out of the house.

3794. And do not perspire?—That is so. Their tissues are not, so to speak, in activity.

3795. So that your opinion would be that next to urine, perhaps the skin is the great excretory organ?—The faeces and the bowels come next to the urine.

3796. I mean apart from the faeces and the urine?—Yes, the skin. The men are mostly obliged to move about. They have to do something, as a rule, and that is the only reason I can give for the difference.

3797. Have you any data which suggests what quantity of arsenic can be taken along with food for long periods without harm?—No; I do not think we are justified in committing ourselves to any statement of that kind. I should not do so, most certainly.

3798. What is your experience with regard to the idiosyncrasy of patients for arsenic?—There is undoubtedly idiosyncrasy. From personal observation I know there is idiosyncrasy towards arsenic in being easily susceptible. As to the converse of that I am not prepared to say. Oddly enough, only yesterday at the hospital I saw a case in which a girl had anæmia, to whom I had given arsenic. This girl was put on five-drop doses of liquor arsenicalis three times a day on the 17th January until the 18th February, when it was ceased on account of the evident indications of poisoning in the shape of coryza, and more particularly throat trouble; nothing else. The arsenic was stopped at once, and the symptoms rapidly subsided. Then on the 23rd February, knowing that arsenic would be beneficial to her condition, I tried her with five-drop doses three times a day of liquor sodii arseniatis, which is a much milder drug. This was continued for four days, and then ceased on account of a manifestation of the same symptoms. In the early part of March she had an erythematous rash on the legs; that was after she had ceased taking it altogether. Then on Saturday last, I think it was, she complained of distinct symptoms of neuritis, tingling particularly when one foot touched the other. The tingling was only in the feet. She had taken at the rate of 1-7th of a grain of arsenious oxide per day for 35 days, which would equal about 5 grains; and then in addition to that she had had about a little over half a grain of sodium arseniate This produced these symptoms. Of course, these amounts are very much below what is frequently given medicinally. It was only given in 1-20th grain doses, three times a day in the first instance. Again, one has seen other cases of idiosyncrasy where even two or three five-drop doses have produced urticarial or other rashes. Those I have seen an odd time or two. Those were cases distinctly of idiosyncrasy.

3799. Reviewing those cases of arsenical neuritis which you have seen, has there not been extreme tenderness of the calves and in the limbs?—Yes; it has been very extreme.

3800. Had you associated that symptom formerly with alcoholic neuritis?—I have seen tenderness, but not this excessive tenderness.

3801. Was that a new feature?—Yes, it was a new feature. Formerly one used to find them tender, but frequently one used to have to grasp the calf of the leg to find it out. But now the patients dread your approach. That is distinctly a new feature, and to my mind one of very great import. Not only is the surface of the leg tender, but the whole of the muscles of the leg are excessively tender, and the patients lie in a crouching attitude, and cannot bear being moved at all.

3802. I believe many had to have cradles to prevent the bedclothes from touching them?—Yes. In those cases of contraction you may get the case of pseudo-clonus by ankle stretching, showing great irritability of the muscles.

3803. Are there any points that you would like to bring before the Commission as to the mode of testing for arsenic?—My observations have been conducted with the two recognised methods—Reinsch's and Marsh's. I have no personal experience, but I should not attach any importance to the so-called Gutzeit's method. Toxicologically you must not only get arsenic, but you must be able to prove that it is arsenic. With this test you get coloration, which may be due to a number of things. It may be antimoniated hydrogen, phosphoretted hydrogen, and sulphuretted hydrogen, and so forth. But in toxicological investigations where you have a man's life at stake you must be able to prove absolutely that it is arsenic. You can do that with Reinsch's test and Marsh's test: you can convert and reconvert and satisfy yourself that the thing you get is what you assume it is. Tests for arsenic compared.

3804. Do you wish to make any remarks of the computation of the amounts of arsenic found in beer?—Judging from the amount I found in the different channels of elimination, I should say that more arsenic has been present in the beer than the analyses have accounted for. I am not criticising the analyses, but that is the impression that I have had.

3805. (*Professor Thorpe.*) Do you mean that by the methods which have been used the quantities obtained have only been approximately quantitatively accurate?—That is my impression.

3806. They are only approximate to accuracy?—Yes. I believe that to make an absolutely accurate analysis of beer with arsenic in it is a very laborious and time-consuming process.

3807. (*Chairman.*) On the whole your impression is that the amount of arsenic in beer has been under-estimated rather than over-estimated?—That is my impression from what I have seen clinically and from the amount I have observed in the excretions.

3808. (*Professor Thorpe.*) That must follow, inasmuch as when the Reinsch method has been at the basis it primarily depends upon the power which the copper has of picking up the arsenic—to the extent that the copper has neglected to take up the arsenic—it will minimise the amount of arsenic which is detected?—Quite so. With Reinsch's test, it is almost like exhausting a vessel of air. With regard to Marsh's test, even in the small amounts in my investigations in which the hydrogen was coming away so small that it would only produce if it was lighted a bead about the size of a pin's head; and, notwithstanding that, you might have an inch of the tube incandescent, I could by its odour detect arseniuretted hydrogen coming away which had not been dissociated. That was corroborated by a piece of filter paper with a drop of nitrate of silver solution, which would rapidly—in two seconds—colour. Coming back to the Gutzeit test, with mercury chloride similarly applied, it took thirty seconds before it was coloured. With the old nitrate of silver method you got in two seconds a slight coloration—holding it close to the end of the tube.

3809. Then you infer from that that mercuric chloride is less sensitive than nitrate of silver?—Yes, that is my experience. On the other hand, nitrate of silver would not do for the test on account of reduction by light. Mercuric chloride is undoubtedly less sensitive to the appreciation of arseniuretted hydrogen.

3810. (*Dr. Whitelegge.*) You attribute the recent epidemic to arsenic?—I do. Toxic effect of arsenic increased by alcohol

3811. Do you attach importance to the association of arsenic with alcohol?—Yes, as regards the capacity of the tissues of the recipient to eliminate—in that sense I do.

3812. The same amount of arsenic administered in another form might not give rise to the same amount of mischief?—Assuming that people do not take alcohol. I do not think that the arsenic being in the presence of alcohol in the beer caused any material difference, but the fact that the people who took it had been beer drinkers, and whose tissues were previously, I take it, more or less impaired, and their eliminative power correspondingly diminished—then you would get accumulation.

3813. Some of them, we were told, are moderate drinkers, but in general the alcoholic habit would render

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them more susceptible to the injurious influence of arsenic?—Decidedly, in my opinion.

3814. Do you attach any importance to influenza or other infectious processes in connection with the recent epidemic?—I have not thought about that.

3815. The suggestion has been made, but we have not had any evidence upon it?—I have no reason to think that they have.

Pigmentation.

3816. Have you made any examination for arsenic in the pigmented parts of the skin?—I have not had the opportunity. It is a very difficult and moot point. It has been hitherto supposed that it was altered blood-colouring matter, and not arsenic. On the other hand, some observers have different views. It is not a settled point as to what the pigmented matter is.

3817. Assuming arsenic to be deposited in the internal organs, is there anything known about drugs bringing it back into the circulation, anything comparable to the supposed effect of potassium iodide in the case of mercury?—No; I do not think there is, and I do not think that any drug would influence it.

No amount of arsenic in food should be declared a negligible quantity.

3818. You are not prepared to say that any amount of arsenic in food is a negligible quantity?—No.

3819. You would not say, therefore, that it would be wise to assert that anything less than 1-20th of a grain in a gallon of beer was immaterial to public health?—I am sorry to have to differ from my friend Dr. Stevenson, who has formulated that, but I do in this instance. I cannot accept the statement that 1-20th of a grain in a gallon would be innocuous. This epidemic has put a lot of negative as well as positive information before us. We have no knowledge as to what the effect would be of the constant ingestion of very minute doses of arsenic. It is difficult to compare the medicinal administration of arsenic, where the doctor and nurse know, and when it can be cut short should anything arise, with the taking of arsenic from multitudinous sources and not knowing it, where symptoms go on increasing and the mischief goes on *pari passu* with the taking. We do not know what the effect is. I most emphatically must decline to associate myself with any limitation whatever.

3820. Even a more stringent one than the 1-20th of a grain?—If you put an absurdly small quantity, of course, one could imagine it to be a negligible quantity; but that would defeat its own object, because it would not be practicable.

No reason to suspect selenium as concerned in epidemic.

3821. (*Chairman.*) Has any suspicion ever crossed your mind that any other substance than arsenic might be to blame for this epidemic?—No. I presume you refer to selenium. I have no reason at all to believe that selenium entered into the matter. I do not doubt that there may have been selenium present, but we know that arsenic will produce these symptoms; and I feel satisfied that there was sufficient arsenic present to produce them. Therefore, in my own mind, I am perfectly convinced that arsenic is the sole factor in the production of those symptoms.

3822. Have you looked for selenium in any of your cases?—No. In the tissues you can hardly look for selenium unless it is present in a considerable amount. In Marsh's test you do not get it over. It precipitates on the zinc. It is stated that you do get it over with the arsenic. That may be so; but I have tried one or two rough experiments with that view with Marsh's test, but I could get no deposit. I have no indication that would afford me any idea that anything other than arsenic was present.

3823. You have not examined any of the beers, have you?—No; it is not in my province to examine beers. I may say, further, that I do not attach any importance to the idea that there is any organic combination of arsenic. I think there is sufficient arsenic present in a simple form to account for the symptoms.

3824. Do you know what the pharmacological action of selenium is?—I do not. There are no instances recorded of selenium poisoning in the human subject. They are all experimental.

3825. It is stated, is it not, that it produces great wasting?—I have seen it stated, but I have no knowledge of it.

3826. Has wasting been one of the great features of this epidemic?—Not beyond a reasonable amount.

3827. Not beyond what you would expect with the paralysis?—No.

3828. In fact, many of these patients have had a large quantity of fatty tissue about them, have they not?—Yes. Casting my eye back, I cannot remember cases of extreme emaciation at all, not as one would get in ordinary alcoholic cases of cirrhosis of the liver, where you get a big abdomen with very thin legs and arms.

3829. But the wasting in these cases has not been out of proportion to the shrinking of the muscles from the paralysis?—Certainly not.

3830. (*Professor Thorpe.*) Were your Marsh mirrors what you might call normal arsenical Marsh mirrors?—Yes.

3831. Was there nothing in their appearance to attract any unusual attention to them?—No.

3832. I presume you are aware that when the selenium is deposited upon a Marsh mirror it gives a brick-red or vermilion tint?—Yes.

3833. Nothing of that kind occurred in the Marsh mirrors that you saw?—No.

Mr. W. R. Deakin, called; and Examined.

Mr. W. R. Deakin.

3834. (*Chairman.*) I believe you are the representative of the Manchester Brewery Co.?—Yes.

3835. Have your breweries been customers to Messrs. Bostocks?—Yes.

Use of Bostock sugar by Manchester Brewery Co.

3836. For how long?—We have been customers ever since we have been a company—about 12 years, and I think before that time also.

3837. Had you obtained both sugar and glucose from them?—Only glucose.

3838. Do you use Messrs. Bostock's exclusively, or do you use other makers' glucose?—Seventeen per cent. of the whole of our glucose was Bostock's.

3839. Do you get the invert sugar which you use from other makers?—We do not often use invert. We use a mixture of invert and glucose—Manbre's.

3840. Do you use invert for priming?—We use this mixture for priming and also for brewing.

Proportion of glucose in beer.

3841. In what proportion do you use the glucose in brewing? I suppose in different brews you use different quantities?—Yes; we use from about 14 to 20 per cent. of glucose, according to the beer.

3842. (*Dr. Whitelegge.*) Is that the percentage on the total amount of brewing materials?—Yes.

Priming.

3843. (*Chairman.*) Do you prime all your beers?—Very nearly all. Occasionally we do not do so in the summer, but you may take it that we prime all our beers.

3844. Do you prime them all in the same proportion?—No; we rather vary the proportions. We use from a pint to a quart. In some fourpenny beers we use a quart, and in the stouts we use a quart; but in the better ales—mild ales and bitter ales—we use only a pint to the 36 gallons, that is at a gravity of 1,150.

Action of brewers on discovery of arsenic.

3845. What steps did you take after the discovery of arsenic in Bostock's sugar?—As soon as we discovered that arsenic was in Bostock's sugar we destroyed all the beer that had Bostock's sugar in it. Every barrel that had any Bostock's sugar in it was immediately destroyed.

3846. You destroyed all the beer that you had at the brewery?—Yes; and in our houses. We sent our agents around to the houses, who personally saw the beer put down the sewers. We did not leave it to the customers to do; we did it ourselves.

Quantity of beer destroyed.

3847. Do you know what quantity of beer was destroyed?—I should think about 1,250 barrels.

3848. (*Dr. Whitelegge.*) Do you supply beer to customers other than the tenants of your own houses?—Nearly all our beer is supplied to our own houses. It is mostly a tied trade, but we do supply private customers.

3849. What did you do with the beer supplied to them?—We only supplied them with bitter beer. Bostock's sugar was only used in sixpenny beers, and none of that was supplied to those customers. We did not

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use Bostock's sugar in any other beer except sixpenny beers. The beers supplied to the private customers were all right.

3850. (*Chairman.*) I suppose none of those sixpenny beers are bottled?—No.

3851. Was any action taken by the sanitary authorities to prevent your selling or using any of the incriminated beer?—At Wolverhampton we were summoned, but we were not summoned anywhere else. We were summoned there on two beers and a stout, one of which had Bostock's sugar in it, while the other two had not. One, however, was found not to contain arsenic after all; and on the other one we were convicted. Our man was going round at the time when these samples were being taken, but he arrived at this particular house half an hour after the sample was taken.

3852. What time elapsed between your being aware of there being arsenic in your beer and your destroying all the beer?—I should think the last barrel was destroyed within two days of our knowing about it.

3853. Then your trade is within a limited area. I suppose you have a good many houses?—I think we had nine people going around destroying the beer, working up to eleven o'clock at night. We had two men going round in the Wolverhampton district where this took place, but they were not quite quick enough.

3854. (*Dr. Whitelegge.*) In the Wolverhampton cases one sample was found to contain no arsenic?—All three chemists differed. Somerset House found arsenic in two cases, but not in the third. Mr. Jones, the Wolverhampton analyst, found arsenic in all the cases; while our own analyst found arsenic only in the one that had Bostock's sugar in it. In the other two he found none. Mr. Jones and Mr. Heron and Somerset House gave totally different analyses.

3855. Could you give us the figures of those different analytical results?—This paper gives them:—

"The samples from the three houses were analysed by three different analysts with the following results:—

In No. 1. Beer (from the "Crown," Wolverhampton).

Brew 692.

Mr. Jones (public analyst) found		·07 grs.	per gallon.
Mr. Heron	,,	·02	,,
Somerset House	,,	·38	,,

In No. 2, Stout (from the "Crown and Anchor").

Brew 693.

Mr. Jones (public analyst) found		·05 grs.	per gallon.
Mr. Heron	,,	nil.	,,
Somerset House	,,	nil.	,,

In No. 3, Beer (from "Royal Oak," Wolverhampton").

Brew 683.

Mr. Jones (public analyst) found		·09 grs.	per gallon.
Mr. Heron	,,	nil.	,,
Somerset House	,,	·19	,,

Case 1.—Tenant fined £5 and 22s. costs.

,, 2.—Dismissed with costs against the Wolverhampton Corporation.

,, 3.—Manager fined £5 and 22s. costs; Company fined £7 and 22s. costs."

3856. Were these three portions of the same samples submitted to three different analysts?—Yes. In two cases the beers were made from exactly the same malt. In one case Somerset House found no arsenic, and in the other they found 0·19 grains. The beers were made from exactly the same malt.

3857. I suppose all these beers would be primed?—Yes; they all had been primed with the same sugar—Manbré's. We never used any of Bostock's sugar for priming.

3858. (*Professor Thorpe.*) Was there any sample of beer which had Bostock's sugar in it?—Yes, that is the case where all three analysts found arsenic. There was no Bostock's sugar in the other two samples.

3859. (*Dr. Whitelegge.*) In the case where the analysts agreed in finding arsenic was Bostock's sugar used in the brewing or in the priming?—In the brewing. There is no Bostock's sugar used in the priming of any of them.

3860. (*Chairman.*) You have never used Bostock's in the priming?—No.

3861. Therefore, you think it would be impossible that by accident some barrels were primed with Bostock's?—Quite impossible.

3862. What steps are you now taking to prevent your beer from being contaminated?—We are getting guarantees from all our customers, both of malt and sugar. With the invoice they send a note that they guarantee it free from deleterious matters. We are also having our beers analysed by Dr. Miller. Brewing materials now being guaranteed

3863. (*Dr. Whitelegge.*) Every brew?—The beer from every fresh lot of malt is analysed, and each consignment of sugar is analysed as it comes in, so we go on brewing from that malt and sugar until it is finished. We send a sample of the beer to be analysed, and then we go on and finish it. Then, when the next lot comes in we have it analysed again. If the first lot is passed as free, we conclude that the whole of that consignment is free. and analysed

3864. Do you analyse the malt and sugar yourselves, or do you only analyse the beer?—We analyse all three.

3865. Do you send samples of every consignment of malt and every consignment of sugar to Dr. Miller?—Not quite, but pretty nearly every one. We have not had any arsenic since December. but not every consignment.

3866. (*Chairman.*) Have you had any difficulty in getting these people to give these guarantees?—We have not had any difficulty; but the maltsters did not like it. This is the sort of letter we get from them. Here is a letter (*produces*) from Sandars and Co., one of our maltsters. He did not like giving a stringent guarantee of freedom from arsenic, though he is willing to accept return of the malt if it does not meet the views of our chemist. In that case we have still insisted on the guarantee. Guarantees.

3867. (*Dr. Whitelegge.*) What was the form of certificate you obtained?—Here it is; it is on the invoices. (*The invoices were handed in.*) I have brought you one of each. Form of guarantee.

3868. Arsenic is not specifically mentioned?—No; it says "deleterious matters." With some of them I believe arsenic is actually mentioned.

3869. Do you suggest any precise terms of certificate, or do they send you some certificate of their own wording?—That is what I ask them to put on. It says there: "Guaranteed free from any substances deleterious to health." We have no difficulty with anyone except our maltsters.

3870. You do not ask whether it is dried with anthracite?—No; we have their assurance that it is.

3871. And this certificate is understood on both sides to cover complete absence of arsenic?—Yes.

3872. Has this demand on your part led to any increase in the price?—No.

3873. Is it within your knowledge how the malt is dried?—We have their assurance that it is dried with anthracite coal.

3874. A general assurance?—Yes. I have spoken to them about it, and they have all assured me that it is dried with nothing but anthracite coal.

3875. Do you ask for any certificate of that kind as regards hops?—No. We have bought all our hops; we have not bought any since this scare came on; we have not any guarantee about that. No guarantee with hops.

3876. Have you had any examined?—Yes, we had one lot examined, and it was all right.

3877. (*Chairman.*) Do you malt for yourselves as well?—No.

3878. You buy entirely?—Yes.

3879. Where do you get the chief quantity of your malt?—Our chief supply is from Sandars, of Gainsborough, and Manns, of Wakefield, also supply us with a good deal. I am in touch with Dr. Miller, and I know their malts are all right in corroboration of their statement.

3880. The bulk of your malt comes from the Eastern counties, not from Shropshire or Shrewsbury, which is a big malting place?—Most of the malt comes from Lincolnshire—I think the majority of our malt this year. We have not had very much Yorkshire, but some of it was made in Yorkshire, on the canal, by Sandars.

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3881. I suppose you are not able to tell us anything about the character of the fuel which was used before this scare in the maltings that you deal with?—I understand that it was coke.

Change from coke to anthracite as malting fuel.

3882. You do not know anything of the source of the coke?—No.

3883. Before this scare used you ever to submit your materials for analysis to anyone?—Yes; we have had a contract with Dr. Miller now for nearly two years.

3884. His analysis, I believe, was only for trade purposes, as he told us yesterday?—Yes. Directly this scare came out, before we knew what it was, I sent samples up to Dr. Moritz, in London, and I asked Mr. Estcourt to come in, and he took samples of the beer as it was going out from the brewery, as well as samples of the materials, and he found that they were all pure. Dr. Moritz corroborated him, and found the samples pure.

3885. (*Dr. Whitelegge.*) When was that?—The last week in November.

3886. Were they reported free from arsenic?—Yes.

Screening and brushing of malt.

3887. (*Chairman.*) Do you make any conditions with the people from whom you get material that it shall be properly screened and brushed?—We have no written agreement; it is verbal. Of course, we have talked to them pretty straight about the whole thing.

3888. You did that before this scare?—Yes. We have always been particular about that. In fact, we dropped one or two maltsters because they did not satisfy us in that respect.

3889. (*Dr. Whitelegge.*) Why did you take exception to it not being brushed and screened?—It makes a great deal of difference, I always think, in the beer if the dirt is in. We screen it at the brewery as well, but it means a lot of work for our own screens.

3890. But you had no suspicion of arsenic?—No, it was simply a question of cleanliness—to get out mould and broken corns, and that kind of thing.

Brewers' books show origin of materials.

3891. (*Chairman.*) Can you trace from your books the composition of your beers and where the materials come from?—Yes. I produce my brewing book. You can see by it that we know exactly what is in every brew. (*The brewing book was produced, and certain entries explained to the Commissioners.*)

3892. (*Dr. Whitelegge.*) Can you trace these barrels?—Yes. As every barrel is racked the number is entered in the book, together with the name of the customer. I have not brought that book with me.

3893. (*Chairman.*) I see by this book that each brew can be clearly traced as well as the sugar, etc.?—Yes. We could trace which had Bostock's and which had not.

3894. You make returns to the Inland Revenue to show the quantity of malt substitutes you use?—Yes. We enter those in the Excise books. We do not enter the hops.

but Excise books do not

3895. (*Dr. Whitelegge.*) You do not enter the details of the malts and the sugar, do you?—We enter the quantity.

3896. The total quantity?—The exact quantity of each brew.

3897. You would not say how much is Bostock's sugar?—No, we should not give the name of the firms. We should say so many hundredweight of sugar, so many quarters of malt, and so many quarters of maize or rice, but we should not give the names of the firms who supply them.

3898. (*Professor Thorpe.*) That is to the Excise officer?—Yes, in the ordinary Excise book.

Excise officers could ascertain origin of brewing material and take samples.

3899. The Excise officer, if he chose, could ask to see the names of the firms?—Yes, and he could take samples if he wished.

3900. If he wished he could know the names of the firms with whom you are dealing?—Yes, we should have no objection to telling him, but, as a matter of fact, they never asked.

3901. I see in the materials here in your brewing book these four columns give malt, corn, sugar, and hops?—Yes.

3902. You put other things besides those into your beer, do you not?—We put preservatives in and finings. I think those are the only two things we put in. Finings, of course, go in, but we do not enter them there.

3903. Do you never use any hop substitutes?—No. Those are the main things. Nothing goes into the barrel except what is down there with the addition of a little preservative.

Finings.

3904. Have you taken any precaution to see if your finings are pure?—I have had them analysed, but only once.

3905. (*Dr. Whitelegge.*) For arsenic?—Yes.

3906. (*Professor Thorpe.*) I suppose you use isinglass?—Yes, with the usual tartaric acid. The finings were quite pure the only time we had them analysed.

Heading preparation.

3907. (*Chairman.*) Is nothing added to give a head to the beer?—Yes. I was wrong in saying there was nothing else. There is a stuff—some sort of sugar I think it is—and I had that analysed as well. That was found to be pure.

3908. There are a great many other substances used in the trade, are there not, to saponify the beer to a certain extent?—I believe there are.

Minute quantities of arsenic in beer not withstanding precautions.

3909. You know nothing about them?—We do not use them. I may mention that the other day we received this letter with regard to a beer which had been passed as being all right. (*Letter handed in.*) You will see it states that one hundredth part of a grain per gallon has been found in that particular beer. How on earth they could detect it I do not know. It is very worrying to our customers, but it does not worry us very much.

3910. This is from the Public Health Department at Stockport?—Yes. We had one once before from there.

3911. Was this particular beer brewed with Bostock's material?—No. It was brewed quite lately, and all materials had been passed as pure. The analyst has found, as you see, approximately one-hundredth part of a grain per gallon.

3912. Had any of the barrels in which this beer was placed before contained beer brewed with Bostock's?—It is possible. It is a quick trade. The barrels are washed and scalded and steamed every time they are used. I do not think there can be anything from them.

3913. (*Dr. Whitelegge.*) Have you traced these samples to their source in this book?—No; I have not had the number of the brew yet. I know there is nothing, however, which has not been passed as sound, because all the beers have been brewed recently—certainly within the last month.

3914. If I understood you correctly, not quite all the samples are submitted to analysis, are they?—No, they are not.

3915. Are the ingredients?—The ingredients are practically all submitted to analysis. All fresh stuff is analysed.

3916. (*Chairman.*) Can you be quite certain when you take a sample of malt that all the quarters of malt are really from the same drying?—We have the assurance of the maltsters that they are. That is all.

Wolverhampton prosecut

3917. (*Professor Thorpe.*) Are you a chemist, or have you had any chemical training?—No. I know enough chemistry to analyse beer for commercial purposes. That is all.

3918. Did you attend the proceedings at Wolverhampton?—Yes.

3919. Was any evidence given as to the methods upon which the various chemists based their statements?—Mr. Heron said he made his experiments with Marsh's and Reinsch's tests, and Mr. Jones said he did his also with those tests. He said that he had tried those tests over and over again. He had only a pint to start with, and he found arsenic every time. They both said they duplicated their tests.

3920. Do you know if their description of the mode in which they applied Marsh's test and Reinsch's test was identical?—I fancy that Dr. Jones said he used identically the same method as Mr. Heron. I believe the question was asked, but I forget at the moment, although I fancy they both used exactly the same tests.

3921. Did Mr. Heron say he used what is known as the experts' test?—Yes, I believe he did, because he described exactly how he had done it.

3922. Mr. Jones did not use the experts' test?—I rather fancied he did not. He had some method of his own.

3923. When Mr. Jones found arsenic he found it in greater quantity than Mr. Heron?—Yes.

3924. And when Somerset House found arsenic they found it in greater quantity than either?—Yes.

3925. The amounts of arsenic found by Somerset House were about twice that found by either of the other experts?—Yes; they were rather more, except in the one case where they found none.

3926. Did you notice anything peculiar about Bostock's glucose as compared with other glucoses that you had been having?—No, nothing at all.

3927. It was not any darker in colour?—No; if anything, it was a lighter colour, but I do not think there is very much in it. It was nice-looking sugar.

3928. Did you notice anything peculiar about the yeasts which you were obtaining during the time of this trouble?—No.

3929. There was nothing abnormal in them?—We had not very much of Bostock's; we had only 17 per cent. of the whole lot.

3930. I am speaking of the yeasts now?—No.

3931. (*Dr. Whitelegge.*) Do you send out any guarantee with the beer you supply to customers?—No; we have not been asked for it.

3932. Neither to your tied houses nor to your other customers?—No.

3933. Would you object to supplying such a guarantee?—With the present system of public analysts, we certainly should. If there is a standard laid down that we could depend upon I do not suppose we should, but now if you send these samples to six different men, not any two would agree, and we should not like to give a guarantee. If there was some fixed standard which was worked to, we should not mind.

3934. (*Professor Thorpe.*) And by a prescribed method?—Yes; and there should be men trained to do the work. If, for instance, Somerset House had the control of it one would not mind, but I do not think we should like to feel we were in the hands of the local authorities, where each different public analyst has some method of his own of making the analysis.

3935. (*Dr. Whitelegge.*) You think in the absence of such a prescribed method the brewers have a grievance?—I think so undoubtedly; we do not know where we are.

3936. If one of your tied houses supplies beer which is found to be arsenicated, of course they inform you?—Yes. The authorities inform us, and they inform the house where the sample is taken from. *Mr. W. R. Deakin.* 26 Mar. 1901.

3937. Is it your practice to defend the case for them?—We have only had the one case I have mentioned, and we defended that for them.

3938. That was at Wolverhampton?—Yes.

3939. Have you had no other cases?—We have had no other cases against us at Manchester and Salford, where the bulk of our business is.

3940. In what way would your position be different if you gave a guarantee, since you undertake the defence?—I suppose they could come down upon us for the loss of trade and all kinds of things.

3941. Would that arise in the case of a tied house?—No; possibly not in the case of a tied house, but in the case of a tenant I suppose he could claim damages. We should not have the least objection as long as there was some standard that we could work to with some confidence. We cannot do so now. You may brew beer with every ingredient guaranteed pure, and the beer passed pure by Dr. Miller, and then we get the sort of letter I have shown you, stating that 1-100th or 1-200th of a grain of arsenic per gallon has been found in it.

3942. Do you know that some breweries are supplying guarantees?—I have seen labels upon barrels; that is all I have seen.

3943. What are the preservatives—sulphites?—Yes.

3944. Have they been analysed?—Yes.

3945. And in all cases they have been found to be free from arsenic?—Yes; there is a certificate of that.

3946. (*Professor Thorpe.*) What steps have you taken to eradicate the traces of arsenic from your plant?—We scour and scrub it well over and over again with sand and all kinds of things which would fetch any rough substance off. We have used bi-sulphite, but I do not know whether that would do it. Arsenic remaining in brewing plant.

3947. Has your company made any claim for the return of duty?—We have not done so at present. I have the telegram here from the Brewers' Association, asking us not to sell beer made from Bostock's; before receipt of which all our contaminated beer sold to customers had been destroyed. I have also here letters from Messrs. Sandars after I had refused to accept that other letter of theirs. Other maltsters have done the same.

Mr. C. Estcourt, called; and Examined.

3948. (*Chairman.*) I believe you are a Fellow of the Chemical Society and a Fellow of the Institute of Chemistry?—Yes. *Mr. C. Estcourt.*

3949. And you were one of the founders of the Society of Public Analysts?—That is so.

3950. I believe you have been Public Analyst of Manchester for the last 28 years?—I have.

3951. And for more than 20 years the administration of the Food and Drugs Act has been carried out by a Committee of the Corporation with the aid of the chief superintendent, Mr. Rook?—Yes.

3952. And I believe you have given advice upon chemical matters yourself connected with such authority?—Yes, up to four years ago.

3953. You also act as Public Analyst for Bacup, Lancaster, and Ashton-under-Lyne and Macclesfield?—Yes, and for Oldham.

3954. You are associated, I think, in one place in Macclesfield and Ashton-under-Lyne with the chief sanitary inspector and at Bacup and Lancaster with the Chief Constable?—That is so; and at Oldham with the Medical Officer of Health.

3955. Would you like to make a statement with regard to what you consider to be your duties as Public Analyst in connection with those bodies?—My duty as Public Analyst would be to ascertain the presence of any compound added to alter the appearance or increase the bulk, or to ascertain if a compound had been deprived of any valuable constituent. No public analyst has imagined nor has it ever been suggested that he should look for all possible contaminations. The Act seems to have been originally intended to prevent fraud. Where a poison is introduced under the third section it is a poison, I take it, which would enable them to imitate or to alter the character of the article so as to sell it to a greater advantage, as in the case of peas which are made green by the sulphate of copper.

3956. (*Professor Thorpe.*) Would not Section 3 also cover a case of the use of a thing like the chromate of lead?—Yes, it would.

3957. And possibly the use of a pernicious green colour for giving so-called pleasant appearance?—That is so. Twenty-eight years ago chromate of lead was considerably used in cheap confectionery in Manchester. A prosecution ensued, and it was stopped. I do not recollect a case since.

3958. Is it not within your knowledge that Section 3 was drafted to cover cases such as those?—Not of accidental impurities, but of intentional impurities. I have in my mind now the possibility of the contamination of milk by germs of typhoid or scarlet fever, and the possibility also of that particular sample of milk being submitted for analysis by the analyst. He passes it, and hitherto he has not been blamed, although as a result of the consumption of that milk some diseases have been spread. That is an organic contamination. Arsenic is an inorganic contamination. That is the whole difference. Neither of them is fraudulent to the Act, because they do not alter the appearance of the article. In the case of arsenic the beer is not altered in appearance, weight, or strength in any particular. Principal duty to detect adulteration.

3959. (*Chairman.*) I think you consider that it is the duty of a public analyst to examine for probable causes of accidental contamination?—That is so. I can give you an example of that kind in the various soda waters of commerce which were formerly conveyed through leaden pipes. We invariably looked for both copper and lead. That is not an adulterant in any sense, but it is a probable contamination.

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3960. And in future, I presume, you would look for arsenic in beer?—I should, unquestionably.

Quantities of arsenic found in beers in different localities.

3961. Perhaps you would give the Commission some information with regard to the analyses which you have made since this poisoning has been found out?—I have received and analysed samples of beer since November 21st of last year from the following authorities: from the Manchester Corporation, 81 samples; from Oldham, 5; from Ashton-under-Lyne, 40; from Macclesfield, 24; from Lancaster, 22; from Bacup, 18. The results in Manchester were that one sample had not less than 1-7th of a grain, ten not less than 1-8th of a grain, one not less than 1-9th of a grain, one not less than 1-12th of a grain, two not less than 1-15th of a grain, one not less than 1-20th of a grain, two not less than 1-30th of a grain, eight not less than 1-50th of a grain, twenty-two not less than 100th of a grain, five not less than 1-200th of a grain, and twenty-eight were absolutely free.

3962. (*Professor Thorpe.*) Perhaps you had better explain to the Commission precisely why you use such a phrase as "not less"?—A public analyst's duties are to certify. He has to be exceedingly careful that he shall not exceed the estimate of the quantity that is there. That is one reason why I have used the term, and one reason why I have estimated so that my quantity would be rather less than the quantity present. I may explain that in making a standard I have taken a standard Marsh mirror obtained from water and not from beer. The consequence is my standard reduces the apparent quantity from beer, as you will see. I got the whole of the arsenic from the water solution practically. You may take it that I get more than I could from beer. If I place a certain specified quantity of arsenic in water and Reinsch it and use the Marsh test with it, I should find a certain quantity as a standard—a certain colour. If I took the same quantity of beer I should get a smaller quantity as a result, which would be a safer test. Taking the water standard and then analysing the beer, my result is always less as certified than is actually present.

Detection of arsenic in beer and in water compared.

3963. (*Chairman.*) But that is rather different from the evidence we have had from others, who have said that the detection of arsenic in beer is more marked than the detection of arsenic in water?—I do not recollect having heard that.

3964. (*Professor Thorpe.*) It has been stated to us by a chemist that it is easier to detect the presence of arsenic in beer than in the same bulk of water?—There should be some grounds given for a statement like that. It is contrary to all received notions, and contrary to all my experience.

3965. (*Chairman.*) I only mention that it has been stated?—It is an extraordinary statement.*

Limits of error in estimating arsenic.

3966. (*Professor Thorpe.*) Have you any idea in your own mind as to the relation between the amounts that you have given and what would be the actual quantities in the beer?—I should say at a guess that 1-8th might be 1-7th, and 1-7th might be 1-6th. That would be the proportion. Of course the certificate of the Public Analyst is subject to the review of Somerset House as well as to the review of the brewer's chemist. The analyst is not in the same position as an investigator, as the gentleman who investigated the matter at Owens College.

3967. (*Chairman.*) I presume the difficulties would be greater when you are dealing with very small quantities than when you are dealing with larger quantities?—Undoubtedly.

3968. What you estimated 1-8th might be 1-7th?—That is so.

3969. But what would it be when you came down to 1-100th?—1-100th might be $\frac{1}{85}$th

3970. Keeping up the same ratio?—Exactly. In the first samples I got, as you will see in the list, there were six which were below 1-30th. Some were 1-200th, 1-100th, 1-50th, 1-30th, 1-12th. As a consequence I had to deal practically with the small quantities only, from 10ozs. or 11ozs., and I had also to deal with unknown quantities as to the composition of the articles; that is to say, instead of being beer, as I had imagined it, it was beer plus something. The highest quantity of arsenic is found in the cheaper beer, and that cheaper beer is one that contains not only preservatives, but it is fined. Directly it gets into the retailer's cellars, he pours in a certain amount of isinglass. Therefore, as received then, the beer would contain a considerable amount of sulphites in some form or another. This I did not know until six days afterwards, when I obtained from a brewer samples of finings, and all the materials he used. I then recognised the character of the beer as sold at the present day.

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3971. (*Professor Thorpe.*) Had the fact that the beer contained preservatives any influence upon the determinations of the amounts you discovered?—It had an influence upon the discovery; but upon the amounts discovered I should say no, because I used the means to get rid of the sulphites in the estimation of every case.

3972. It would prevent your recognising arsenic in the first instance?—It did.

Arsenic n detected account o presence sulphite.

3973. By inadvertently not ascertaining the existence of the sulphites you failed to discover the presence of the arsenic?—By not knowing that the sulphites were present in the beer.

3974. You knew that sulphites might be present in beer, did you not?—Not in beer.

3975. You were not aware that sulphites were used as a preservative?—No; I was aware that sulphites were used, bi-sulphite of calcium, to wash the barrels with, but never that it was added to the beer.

3976. You understood that preservatives were added to the beer, I presume?—I cannot say that I did. I had not the faintest idea that sulphites were present.

3977. (*Chairman.*) You put in this table with regard to Manchester?—Yes. (*See Appendix, No. 9.*)

Quantiti arsenic f in beers different localitie

3978. And you also put in a table with regard to Ashton-under-Lyne?—Yes. You will see that the amounts of arsenic per gallon varied from 1-7th of a grain to 1-200th, and seventeen of the samples were free from arsenic.

3979. And you also put in a table with regard to Macclesfield, Bacup, and Lancaster, and a summary of results obtained by you when analysing beers submitted to you by brewers?—Yes. (*See Appendix, No. 9.*)

3980. Do you know where the brews were brewed?—Yes; I can give you the particulars if you like.

3981. Did you find any arsenicated beers excepting those that had used Bostock's materials?—In brews brewed entirely from malt and hops I found arsenic also.

Arsenic all malt

3982. (*Dr. Whitelegge.*) What was the most in those cases?—I think I got from 1-4th to 1-50th of a grain per pound.

Arsenic malt.

3983. (*Chairman.*) Was that in the malt?—Yes.

3984. I am speaking of beer; that was in your samples of malt?—Yes; I obtained the malt from which the beer had been brewed in which I found arsenic.

3985. You first found it in the beer, then you obtained samples of the malt and found it in the malt?—Yes.

3986. (*Dr. Whitelegge.*) How much was there in the beer?—I found 1-10th of a grain, if I recollect rightly.

3987. (*Professor Thorpe.*) One-tenth of a grain per gallon?—Yes.

3988. (*Chairman.*) I believe you have made numerous analyses of glucose, invert sugar, and caramel?—Yes, with the result that I found two other glucoses containing arsenic, one in a considerable quantity.

Arsenic non Bo glucose,

3989. Not Bostock's?—No.

3990. Do you know from whom they came?—I can give you the name of one. The other was an American firm. The one that contained the most was German made. Julius Frank and Ohlmann was the name.

Of Ger and Am origin,

3991. They were both foreign?—Yes, I presume so.

3992. (*Dr. Whitelegge.*) How much was there of the samples?—Enough to make 1-20th of a grain per gallon if 20 per cent. had been used. I am taking that 8 ounces might be used to replace the malt in these cases—taking 42 ounces of malt to make a gallon of beer, which weighs about 10lbs., and replacing a portion of the 8 ounces with sugar it becomes about 1-20th of a

Note by Witness.—As an illustration of the fallacy of this, three public analysts analysing portions of the same sample of beer found respectively 1-10th, 1-12th, and 1-25th grain. One thus lost half the quantity present. All would have got correct results from a solution of As_2O_3 in water.

grain. The quantity of arsenious acid estimated to exist in 1lb. of the glucose was $\frac{1}{10}$ of a grain. The estimation was by means of comparative Marsh mirrors.

3993. (*Professor Thorpe.*) Was that German glucose you refer to being actually used in the manufacture of beer?—It was from a brewer's premises.

3994. In this district of Manchester?—Yes.

3995. (*Chairman.*) And in the American glucose you also found arsenic, but in a less quantity?—Yes.

3996. Was that also obtained from the premises of a brewer?—Yes, from premises of a brewer in the neighbourhood, though not in Manchester—a town 20 miles away.

3997. Do you think that it was being used for beer?—Yes; it had undoubtedly been used.

3998. For beer—not for any other purpose?—Yes, they used it for beer.

3999. Still, glucose is used for other purposes?—Yes, for a number of other purposes, jams and various sweetmeats.

4000. Have you made any analyses of jams?—Yes, I think I have given you some figures.

4001. (*Professor Thorpe.*) Was this German glucose which you got from the brewer the only sample of German glucose you got from a Manchester brewery?—It is the only German glucose that I know of.

4002. Can you tell us whether imported German glucose is at all extensively used in this district?—I should say that this particular glucose had a considerable sale, as I met with it in several other breweries.

4003. I understood you to say that you had not?—Yes.

4004. This German glucose?—Yes.

4005. It contained arsenic?—Not in all cases. This was a case where the beer appeared to contain a very small quantity of arsenic. They used none of Bostock's. They bought at the best prices, and they got this particular glucose from Julius Frank and Ohlmann. He gave me a sample of another stock in which I found a faint trace; but afterwards in the brewery to which I allude I found some glucose from Julius Frank and Ohlmann which contained a much larger quantity, the quantity I have spoken of. The glucose of that firm has a considerable sale in the neighbourhood.

4006. What do you mean by a "considerable sale"?—They supply several brewers.

4007. To what extent?—I cannot tell. The brewers appear to buy in a very peculiar way; that is to say, they have three or four makes of glucose in at a time. They used in a most extraordinary way mixtures of the glucoses according to the taste of the brewer. Although I cannot tell you to what extent it is sold, I should say there is a considerable sale. Their business is entirely glucose.

4008. As these breweries which use this German glucose in which you found the arsenic large breweries?—I have not been to the breweries, but I should say they are of considerable size.

4009. This is the first distinct evidence we have had of the occurrence of any notable quantity of arsenic in any other than Bostock's glucoses?—I wrote to the Officer of Health here on the 7th December, and told him that there were two other glucoses in which I had detected arsenic. I think, however, I am not alone in this, for Dr. Campbell Brown also says that there are two other cases in the report.

4010. Is not that a case where Bostock's glucose was supplied to an agent?—No; I have a case of that sort from a brewery. Dr. Campbell Brown alludes to two other makers.

4011. Is this particular German glucose of which you have told us used to your knowledge in Liverpool?—I could not say.

4012. Is the other sample of which Dr. Campbell Brown made mention the same as this you referred to?—I do not know. I only read his published report in the papers.

4013. Do you not know what the sample of glucose was with regard to which Dr. Campbell Brown made a report?—I do not.

4014. (*Chairman.*) Perhaps you would hand in the name and address of the breweries where you found the arsenicated German and American glucose in use?—I will look them up, and will give you both names. I may also be able to send you some of the glucose.

4015. (*Professor Thorpe.*) Have you some of the glucose still in your possession?—I think I have; and I think I have some of the malt. I am not sure that I have some of the worst samples, but I have some of the malt that is bad.

4016. And what about the glucose?—And of the glucose as well. I have examined beers from Yorkshire, London, Burton, and Hampshire. In the London beer I found none; in three towns in Hampshire from which I obtained fourpenny beer I found not a trace; in one of the Yorkshire beers I found a quantity equal to what we had in Manchester; in the Burton beer I found a small quantity, 1-100th of a grain.

4017. (*Chairman.*) Did you find any contaminated caramel?—Nearly all caramel seems to be contaminated. I met with very few samples that were quite free; whether they were made from Bostock's sugar I cannot tell. I should say, however, that it was evidently from the same source. Arsenic in caramels

4018. I understand from Dr. Thorpe that glucose which is off-colour is sometimes still further treated to make it into caramel?—Very probable. That might be the reason.

4019. (*Professor Thorpe.*) Are you able to tell us whose caramels they were, whose samples you examined?—I can ascertain the names, but I did not get them at the time.

4020. How did the caramels come into your possession?—From the breweries. obtained from brewers.

4021. Was there nothing on them to indicate whose make they were?—There was nothing on them except the name of the brewer. The majority of the samples came to me with the name of the brewer and the name of the substance.

4022. What quantities of arsenic have you found?—I have found large quantities.

4023. How do they compare with the amount of arsenic which you have found in the German glucose and Bostock's glucose?—I should think not more than one-seventh or one-eighth probably.

4024. Is the amount of arsenic you found in the caramel larger or smaller than the amount you found in Bostock's glucose?—Smaller.

4025. That would rather negative the supposition that this caramel had been derived from Bostock's glucose?—It would, from this particular glucose, but one does not know what the other glucoses may be.

4026. (*Dr. Whitelegge.*) Do you still find traces of arsenic in caramel?—I have not received any caramel lately. The caramel, as one understands, is to replace the old burnt malt to colour the beer with. With respect to the yeast, in that particular brewery where I met with this German glucose I examined it, and then informed the Medical Officer on the 1st December that arsenic was found in the yeast in considerable quantities. Since then I have had 23 samples of yeast, representing nearly all the Manchester breweries. These yeasts are from a yeast merchant who is anxious to know when they are pure again. I found from 1-30th to 1-100th grain to the pound. Arsenic in yeast.

4027. (*Professor Thorpe.*) This yeast that you got from a yeast merchant may be an imported yeast, may it not?—No. He purchases the yeast from Manchester breweries, presses it, and sells it to distilleries, etc. In this case he was anxious to find out whether the arsenic was got rid of. It was practically got rid of by January 17th.

4028. Do you know anything about the origin of those yeasts?—I know, for instance, that in one case, the brewery I spoke of, where I discovered the arsenic in the yeast, they had received a store of yeast from Groves and Whitnall. They exchange when the yeast gets sick, and although it is worn out in one brewery it revives in another. I suppose it is the fresh soil.

4029. Groves and Whitnall have not used any of this German glucose to which you have referred, have they?—I presume they have not.

4030. But that is not the brewery that you are going to give us the name of?—No.

4031. Do you know whether the yeast to which you have referred was derived from this German glucose?—No. I understood from the brewer that he had purchased or obtained a new sort of yeast from a firm of

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brewers where Bostock's sugar had been used, and he attributed the presence of arsenic in the yeast to that fact.

4032. (*Chairman.*) He had obtained it from Groves and Whitnall?—Yes.

4033. (*Professor Thorpe.*) Is the arsenic in the yeast in your opinion derived wholly through the intervention of Bostock's sugar; can you trace it back again to the use of Bostock's sugar?—In the majority of cases of yeasts submitted, I should say yes.

4034. The yeasts which you have examined have had their arsenic, in your opinion, derived from Bostock's sugar?—Yes; that is my opinion.

4035. (*Chairman.*) Will you proceed with your statement?—I have made a suggestion in view of the fact that there are very many differences between analysts, not only in the method and results, but in their way of treating the samples, that it would be advisable to form some committee which would deal with this question. I have had a letter from the Society of Chemical Industry, and they are forming a committee, and they have asked me to take part in formulating a method of dealing with arsenical samples, and the process of detecting arsenic. I may say that beneficial results were obtained from the Milk Committee, and that in the end the major portion of the analysts used one method in dealing with the milk. I submit that something like that is required in respect to arsenic.

Need for a standard test for arsenic.

4036. That there should be one uniform method of working and one uniform test?—Yes, one quantity, and that the quantity should be absolutely the same. The question also arises of making the standard accurate. I have suggested that the committee which deals with this should also make one standard solution, which should be sent down to every analyst, so that there should be no possibility of any difference even in the standards. I am not sure that all the standards taken by the analysts have been absolutely accurate—that is to say, they have made up solutions of arsenious acid. The standard is made up of a certain quantity of arsenious acid dissolved in water.

4037. A standard of what?—A standard of mirrors or of Reinsch's, or any process you want. You want a standard.

4038. (*Professor Thorpe.*) I think you had better explain rather more fully what you mean, because it is quite possible to determine the amount of arsenic irrespective of any such standard?—Quite so. I am talking of minute traces, which are all that exist now in beer. When you have to deal with small traces you cannot use a method of weighing, and therefore the method adopted in Manchester has been to make a solution of a certain amount of arsenious acid and analyse it, and produce a Reinsch sublimate or a Marsh mirror from it. It is not supposed or expected that we are going to work for weighable quantities. That there would be no difficulty about, but we are working for very minute quantities—that is, the quantities obtained from malt, I presume. The object would be to deal with minute quantities, not large quantities, which could be obtained by precipitation.

4039. Why do you make that restriction?—It is only a question of the initial amount of material taken, is it not?—Quite so. If you have gallons and 100th of a grain to a gallon you could get a weighable quantity, but commercially you cannot obtain a large sample. In the purchase of everything it is the same. You could not obtain a sample probably if you sent for an abnormal quantity. If the beer is sold in half-pint bottles the analyst may only get 3½ ounces to analyse.

Sample demanded for Public Analysis must not be too large.

4040. (*Chairman.*) What would be the limit of quantity that you could obtain for a sample?—If you asked over the counter for a gallon of beer it would cause suspicion. The person who would go for it would generally be an inspector, and he would appear as a very unlikely person to carry a gallon of beer away, and it would be refused. There is no penalty for refusal compared with the penalty for adulteration. There is only a £10 limit for a refusal, therefore it is cheaper to refuse to sell than it is to be fined for selling. That is why our inspectors have to take special precautions in obtaining samples, because they may be refused.

Retailer may refuse to supply.

4041. (*Professor Thorpe.*) Does not that rather point to a defect in the Act?—I agree with you there. It was suggested years ago that the penalty for refusal should be greater than the penalty for adulteration, but in the last Act it was not changed, notwithstanding the feeling of our committee. It is still £10 for one offence and £20 for the other.

4042. (*Chairman.*) Apart from that difficulty of sale being refused for the purpose of analysis, there would be no practical difficulty in taking, say, a gallon as the quantity which should be taken for analytical purposes, would there?—Apart from that there would be no difficulty.

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4043. You think that if you could have a standardised solution, from which comparative tests could be made, that would do away with some of the great discrepancies which now exist in the analysis of some beers?—That is so, granted that the method and the quantity are identical.

4044. (*Dr. Whitelegge.*) You do not agree with what a former witness told us, that this ought to be left to the discretion of the public analyst?—The public analyst would probably, if he were assisted by Somerset House, devise some method which is uniform; but it can be done at once if the Commission suggested it.

4045. But you think that all public analysts ought to be called upon to conform to an official method for analysis?—I do, undoubtedly.

Action by M. O. H. t destroy arsenical beer at a brewery.

4046. (*Chairman.*) You mentioned that at Blackburn the Medical Officer of Health at once obtained samples of beer from the incriminated brewery, and after analysis of the samples ordered the brewer to destroy all the beer brewed with Bostock's glucose, and left the inspector to see this done. Had he power to do that?—No, he had no power to do that. I heard that given in evidence in the case of *Holden v. Bostock*, in which £1,800 was given as damages.

4047. The beer was destroyed through the goodwill of the brewer?—I grant that; but my view is—and the Officer of Health for Blackburn thought the same—that you can ask the brewer to say which beers are the ones which are not brewed with Bostock's. You then sample those beers, and upon his word you would take them. If, upon analysis, you found them to be wrong, then you would have an opportunity for an action; but in the case of this arsenical scare it appeared to me that all the brewers were quite willing to accept the situation, and would, had they been pressed by any of the authorities, have destroyed all their beer before an official, so that the Corporation would have had the credit of having done something in this direction.

Bostock sugars not destroyed by Sanitar authority.

4048. You go on to say that you did not know that the Liverpool authorities ever destroyed the poisoned glucose at the manufacturers, but they certainly had the power to do so*?—That is a power under the Public Health Act—on analysis, and discovering that it contained arsenic, and was to be used for food. The amending Act of 1890 covers all that. The first Act restricted the articles you shall deal with, while the amending Act includes everything that can be used for food—that is the 1890 Act, and it gives power to destroy deteriorated food as you might tinned meat or arsenicated flour, if you can imagine such a case.

4049. Would that give you the power to destroy glucose before it had entered into the composition of a food?—Certainly—anything intended for food. Glucose is practically a food of itself. The glucose itself might be made a food.

4050. But would you actually consider glucose as a food?—Take the case of flour. I would consider glucose as much a food as flour. Flour is not eatable unless there is some change, that is, until it is cooked. In the same way glucose would not be, until it is made into a sweet. But, at the same time, it is evidently covered by the Act.

4051. (*Dr. Whitelegge.*) Are not those further powers under the Public Health Act Amendment Act adoptive?—There was an opportunity of using them here, but no authority apparently has attempted it. The reason is this, that you might find on analysis of a beer that one particular barrel is arsenicated; but the question is, how dare you seize those other barrels? Because you do not know that they contain arsenic; you have only analysed one. It would be a cause for law suits and a claim for damages against the authorities. In this case I say there would not be an atom of difficulty owing to the feeling of the brewers upon the subject.

4052. Because of the amending Act?—The amending Act enables them to do it. You can point out the very thing. Bostock's sugar enables them to point it out, because the brewer's books would show in which brew it was used.

* *Note by Witness.*—I find Bostock's works are not within the City of Liverpool, so that the above remarks should not apply to Liverpool.

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4053. The amending Act gives certain powers?—Yes.

4054. Those powers do not come into effect in any locality until the local authority has deliberately adopted that Act; is not that so?—I did not read that, but it may be so.

4055. Do you know whether that Act has been adopted in Blackburn and Liverpool?—I do not know.

4056. Or in Garston?—I cannot speak to that.

4057. (*Professor Thorpe.*) Has it been adopted here?—The original Act has been adopted here.

4058. (*Dr. Whitelegge.*) I am speaking now of the Public Health Acts. The original Act would not want adoption; but the amending Act does?—I see what you mean.

4059. Do you suggest if the adoptive Act is enforced that the medical officer of health would have power to go to the brewery to ask the brewer to distinguish those likely to be contaminated from those not likely to be contaminated, and then to take a sample for analysis?—He might take a sample for analysis eventually.

4060. And then take no further action until he received the result of the analysis?—He could ask them to point out the contaminated barrels. As I say, the mood of the brewers was such that they would have done it at once. I do not say that it would have been successful ordinarily, but in this case it would have been the easiest method of dealing with it.

4061. Even if the adoption of the Act were enforced locally, it would not give a medical officer of health power to deal with an emergency unless the brewer gave him the facility?—That is so; but that drawback applies to all foods. It might apply to flour or any food you like. If you have a suspicion that flour is adulterated, and the miller or the large flour dealer is at fault, you analyse a sample, but you cannot seize the rest without information from him.

4062. Has it to your knowledge been the practice to seize large quantities of food supplies of any kind after an analysis of samples? Has not the action taken by local authorities in condemning large quantities of food supplied been limited to those cases where they were determined to be bad by the inspector?—I will take the case of tinned meats. There are some cases—take, for instance, what is called the blown tin—where it is quite feasible that some decomposition has set in. I read a case the other day where they had actually bored these tins at the Stores to allow the gas to escape, and then sealed them up again. Yet those were seized.

4063. On analysis?—I cannot say on analysis; I suppose on opening one of them.

4064. That is by inspection, not analysis?—Yes.

4065. The suggestion is that beer or any other substance dangerous in a large quantity, which could only be proved to be dangerous by analysis, should be seized after analysis; that is a suggestion, and not a record of experience?—It is simply a suggestion. As I say, the difficulty in the Act applies to every food.

4066. (*Chairman.*) As a matter of fact, no Bostock's sugar was sold or sent out from Bostock's after the first suspicion that their sugar was connected with arsenicated beer?—I understand from the evidence, not.

4067. So that really the non-action of the Liverpool authorities, which you have stated to us, had no effect with regard to Bostock's?—One cannot tell. They say that none went to the brewers—that is their evidence—and that they received large quantities back from the brewers. But what was done with it no one appears to know.

4068. What you would wish us to infer is, that at present nobody knows what has become of Bostock's stocks?—Yes, whether it has been destroyed by them or not.

4069. (*Professor Thorpe.*) No one officially knows?—That is what I mean.

4070. (*Chairman.*) Then you go on to speak of a case in which beer containing $\frac{1}{8}$th grain of arsenic per gallon was sold as late as the 2nd January?—Beer containing $\frac{1}{8}$th grain was sold as late as the 2nd January, or six weeks after the discovery of arsenic in beer. I say if action had been taken, however improperly, under the Act, as was done at Blackburn, that could not have occurred.

4071. How did it occur that that beer was sold?—The brewers did not keep their promise.

4072. (*Dr. Whitelegge.*) Are you referring to a Bostock beer?—I think it was a North Cheshire brewery company. The case was reported in the paper on the 12th of this month. It is a brewery not very far from Manchester.

4073. Where was the prosecution?—I forget where it was, but I can supply you with a cutting. Not only is that the case, but in two of the towns for which I am analyst, on the 12th December beer was being sold containing 1-7th and 1-8th grain of arsenic respectively. You will see in the Manchester case that the last sale of beer containing a considerable quantity—1-8th of a grain—was on the 6th December; and after that they came down to what I presume were derived from malt, 1-50th and 1-100 of a grain. But on the 6th December there was one brewery in Manchester which sold beer containing 1-8th of a grain.

4074. Was that from one brewery or one house?—It was from one house. I have the name of the brewer. It is No. 2.

4075. (*Chairman.*) Might that have been an accident?—Yes. I am not suggesting anything more than that beer containing that amount of arsenic was being sold in two towns.

4076. (*Professor Thorpe.*) But have you any knowledge of this fact? We have had evidence from this particular brewery, and we have had evidence that everything to their knowledge was done to destroy the incriminated beer; and yet you tell us that so late as December 6th beer from that particular brewery was being sold?—It is not only the fact—I have certified it. The summons was issued with regard to that.

4077. Do you know the reason why this particular lot of beer escaped destruction?—I have no knowledge of anything about that. I could not even tell you where it came from. I know the brewer's name was given to me, but I have no knowledge whatever of the circumstances under which the sample was taken.

4078. (*Dr. Whitelegge.*) Are proceedings pending in that case?—I believe so. One of the other brewers—No. 3—was selling in one of these towns as late as December 12th, and that beer, I believe, contained 1-7th of a grain.

4079. (*Chairman.*) That would not be in Manchester?—No. It was in Lancaster. No. 3 I find did sell beer in Lancaster on the 12th December containing 1-7th of a grain.

4080. (*Professor Thorpe.*) How do you reconcile these two circumstances with your previous statement that to your knowledge the brewers were doing everything they could to destroy the beer?—This is an individual house from which samples were taken. I do not suggest that all the brewers' public houses contained arsenical beer. I have no knowledge of it at all.

4081. But this was taken from a tied house, was it not?—I cannot tell you. I know nothing about it, except that I had a sample, and on it was the name of the brewer.

4082. But not the name of the public house?—No.

4083. But the action was brought against the licencee of the public house?—I have nothing to do with that. I never know until I go into court against whom the prosecution is directed.

4084. (*Chairman.*) Have you any suggestions to make with regard to the prevention of such an occurrence again?—It does not appear that the Food and Drugs Act would have any value. At least ten days to a fortnight would elapse before a summons could be taken out, as the analyst's certificate goes before a committee, and then probably another fortnight before the hearing of the summons. During that time there is no inducement for the brewer to destroy the beer—none whatever; he can continue selling.

F. and D. Acts insufficient to secure destruction of arsenical beer.

4085. As a matter of fact, the brewers acted very differently, and did destroy the beer, did they not?—There is no doubt about it in the cases which you have before you, but I do not know that that was the case in all instances.

4086. It is against their interests to destroy the beer?—Yes. In the case of Groves and Whitnall they did destroy the beer, and I have no reason whatever to doubt that their claim against Bostock's shows the amount they did destroy. You may go so far as to say that some brewers were extremely scrupulous, but you cannot say

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that all were equally so, because you have the proof of its being sold as late as I say in one particular case as January 2nd.

4087. (*Dr. Whitelegge.*) But you do not infer that the example of Groves and Whitnall was not generally followed?—I hope it was.

4088. Have you any reason to believe that it was not?—None, except the evidence given here—that there was arsenicated beer sold afterwards. I do not suggest anything from that. It may have been an accident; it may have been a small quantity left in one house. But I do suggest that some better method should be invented to deal with this matter.

4089. (*Chairman.*) In the public interest in the future?—Yes. The brewers may and are from their position and from their large capital largely before the eyes of the public, and therefore it may be probable that they may have acted as Messrs. Groves and Whitnall did, and got rid of the whole of it; but you have the smaller manufacturers to deal with in the case of food, and the Sale of Food and Drugs Act does not help you a bit; it does not get rid of the poisoned food. As Dr. Thorpe mentioned, even if you had the power to get a sample from the brewer that power was limited apparently under the last Act, because it was suggested that it would be very unfair to grocers that inspectors should get samples of their stock from their carts, because it might destroy some customer's parcel. It was only permitted to take in transit with the consent of the retailer or the purchaser. That could have been done in this case, I daresay. I do not doubt that any of these tied houses would very gladly have consented to samples being taken from the barrels at the door when they were being delivered; but at the same time that rather puts a hindrance in the way of dealing with the brewer if consent of retailer must first be obtained.

Samples in transit can be taken, but consent of purchaser necessary.

4090. (*Dr. Whitelegge.*) But in any case the proceedings would be directed to the penalty and not to the destruction?—The penalties are very small. In the case I alluded to of January 2nd the penalty was much less than the total amount might have been.

4091. (*Chairman.*) Therefore your suggestion would be that the Food and Drugs Act should be remodelled or improved?—No, the Public Health Act. I say it appears to be unworkable. If you have a large flour dealer with a stock of flour—and there have been cases known of arsenic in flour, ages ago—that if you find one sack sent out containing arsenic, and you went to the flour dealer, you could not seize his stock because you would have to analyse each sack separately. The Act is unworkable. I cannot suggest how to make it workable, except that you could put an embargo on the whole of the deleterious food if one sample was found to be wrong, and not allow any stock to be sold until it had been ascertained which sacks were free and which were found to contain arsenic. That is the only way in which the Act could be made workable.

Power under P. H. Acts desirable to restrain sale pending analysis desirable.

4092. (*Dr. Whitelegge.*) Would that be workable in the case of a large factory?—I think so. It would be in the case of a brewery, that is certain. The whole of the brews are stacked up and every cask marked with the date and every detail. Every cask could be identified. They could say: "That pile there of 1,000 barrels was brewed with Bostock's sugar, and that one is free."

4093. Do you suggest that the local authority or their officers should have power to go into the brewery or on to a manufacturer's premises and lay an embargo upon such goods as they thought, pending analysis?—Yes.

4094. And you would allow a fortnight for the analysis?—No, not necessarily. A day would do.

4095. But in the case of proceedings under the Sale of Food and Drugs Act, we were given to understand that a fortnight must elapse before you could lay an information?—No, some of them were laid in seven days; but by the 1899 Act they cannot take place until 14 days from service of summons. I may say that when I certified I had not the faintest idea that action would be taken under the Sale of Food and Drugs Act, having the view that we were not the proper officers to take notice of accidental contamination. I had not the faintest idea. I was asked to certify, and I certified.

Standard tests for arsenic should be official.

4096. (*Professor Thorpe.*) You quoted, as an example of what you suggest should be done, the precedent of the Committee of the Society of Public Analysts in the case of milk?—Yes

4097. That was, I suppose, when you took over what you called the standard method?—That is so.

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4098. The Adams' process?—Yes.

4099. Do you suggest, as the result of such action, that what did actually happen in the case of milk should also happen in the case of arsenic?—You have the power to recommend that a certain method should be adopted. We had no such power.

4100. As the result of the action of your committee, you put your heads together and officially adopted what is known as the Adams' coil process?—Yes.

4101-2. And almost immediately after that all of you did not use it?—I cannot say that. A great many used it. For instance, I used it in the case of adulterated samples.

4103. Do you use it now?—I do.

4104. Is that process generally in use by the analytical profession?—I should think so, for adulterated samples. When you get a sample you can ascertain by the Wanklyn process practically whether it is a fairly good milk or adulterated. To determine the amount of adulteration you must use this method. I use it.

4105. Do you know any other analysts who use it?—I think Hehner uses it.

4106. Have you read the report of the Committee on Milk Standards?—I have only read a portion of it.

4107. You have not yet read the evidence?—I have got the evidence, but I have not read it all.

4108. Have you got as far as the evidence which shows that practically scarcely any analysts use the Adams' coil process?—I have not noticed that.

4109. The President of the Society of Public Analysts does not use it, the Vice-President does not use it, the honorary secretaries do not use it; practically few officers connected with the Society of Public Analysts uses the official method. Do you think your suggestion that the Society of Public Analysts should now meet together and prescribe an official method, is likely to be more successful in the case of arsenic than in the case of milk?—I am suggesting that you would probably endorse the views of the committee if they submitted them to you. I am suggesting that this should be made an official standard. I daresay that the Society of Public Analysts would find very efficient men; but, at any rate, it must be made absolutely official, in order that it may be of any value at all.

4110. I concur in the principle of your suggestion, but, unfortunately, your illustration is not quite fortunate?—The failure is because it was not made official by the Government. That is all.

Form of P. A.'s certifica

4111. (*Dr. Whitelegge.*) What form of certificate do you use?—There is a modified form. You may recollect, probably that the mere expression of opinion of the analyst as to the amount of water was accepted, but that was upset. It is a decision of the High Court. The form that the Society of Public Analysts desire should be used, and which I have been using recently, is: "This milk is composed of 90 parts of milk and 10 parts of water." This opinion I base upon the fact that the solids not fat are so much instead of so much—that is 8·5; and by a simple calculation of these figures you can make out this as 10 per cent.

4112. What form of certificate would you use in the case of beer? If you certified beer as containing arsenic, in what terms would you certify?—"I certify that this beer contains not less than one-eighth of a grain of arsenious acid per gallon."

Quantity of arsenic beer wh should call proceed

4113. In what terms would you report to the authority who furnished you a sample of beer, if you found it practically free from arsenic?—I have made several reports recently. On the 15th December I wrote to the Corporation describing my discovery of large quantities of arsenic in malt. Since then I believe they have modified their view as to the quantity with regard to which they should take out summonses. They were taking out summonses for one-hundredth of a grain per gallon. I have nothing to do with the taking out of summonses myself, but I should not advise taking out summonses in cases in which there was less than one-thirtieth of a grain.

4114. You have not advised the Corporation, I believe, for the last four years?—Practically no. For 24 years a committee which had the word analyst attached to it sat, and I met them at stated inter-

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vals. For the last four years that name has been left out, and there is no Analyst Committee, and, as a consequence, I never met them. Some of the committee which deals with my certificate, I presume, do not know me at all.

4115. You have not given us the form of the certificate you use in a case in which you came to the conclusion that one-hundredth of a grain of arsenic per gallon was present in the sample?—I write and say number so-and-so contains simply a trace of arsenic, or contains less than one-fiftieth of a grain. I understand that the Corporation are not taking action in cases of less than one-fiftieth of a grain, so that I simply report the presence of arsenic in these samples to the extent of one-fiftieth, or one-hundredth of a grain, or whatever it might be, without certifying.

4116. And when you do not think a case is one for prosecution you use the expression "less than"?—I do not certify then.

4117. You make a report without certifying?—Yes.

4118. (*Professor Thorpe.*) When you say they are not taking action in cases above a certain limit who has been the authority to guide them? How have they arrived at this limiting value on which action should be taken?—I should imagine the Town Clerk advised them. My suggestion was to some extent taken, but not the limit I gave. I said that action should be taken in the case of all samples where the contamination was more than one-fifteenth of a grain per gallon. I believe that of all samples of beer which derive their arsenic from the malt none contain more than one-fifteenth.

4119. (*Dr. Whitelegge.*) But over one-fifteenth?—I considered it was attributable to Bostock's glucose, and in my suggestion of the 15th or the 17th December I said that if they took proceedings under the Sale of Food and Drugs Act they should not take out summonses against retailers whose samples showed less than that amount.

4120. Do you consider 1-15th of a grain harmful?—I am not a medical man, but I think it is too much to have in beer.

4121. You said that if you were advising you would advise that no prosecution be instituted for less than 1-30th?—Yes.

4122. Is that because you think that arsenic at the rate of 1-30th of a grain per gallon could not be harmful to anybody?—No. The reason is because it is due to the malt, and I know that you cannot eliminate it from the malt. It may take some time before maltsters will institute a new process which will do away with arsenic in malt, and therefore as a practicable quantity I have suggested that amount.

4123. (*Professor Thorpe.*) I should have thought that a few prosecutions would have considerably accelerated the rate at which the change would take place?—The change is a tremendous one, but it is not so great as I thought. I have received this morning a description of the pneumatic development of the malting system. The malting system was a very crude and rough method of old, simply wetting some barley, throwing it on the floor, and moving it about in various degrees of thickness by men by rule of thumb. Since then a very elaborate process has been devised of making malt in cylinders. But in this method, if they used the coke they used formerly, it would increase the quantity of arsenic in the malt enormously. Instead of beginning the process by putting the malt on the floor after it has been steeped they now begin it by drying it in these cylinders, through which the fumes are driven. So that they begin to arsenicate the malt seven or eight days before it would be arsenicated in the ordinary kiln. Surely if they could afford an elaborate process like this—an entire change in the malting process—they could afford the very little that is necessary for drying in cylinders, without allowing the fumes to come into contact with the malt at all. I may mention that a brewer visited me the other day in consequence of my having found a small quantity—1-35th of a grain—in his beer. He said he had used no Bostock's glucose, and that he was certain his malt was free. I said to him, "When did you make your stock of malt?" He is a maltster as well as a brewer in Lancashire. He said, "We might have some of the old coke-dried malt left." I said, "Do you see any difficulty yourself in devising a method of drying the malt without allowing the fumes to come into contact with it at all?" and he said, "I do not." I said, "Why should not you be the first to do it?" This was the managing director of the company, and he said, "We intend to do it. We are going to dry the malt without the fumes coming into contact with it at all." A large malthouse has been put up here recently, within the last three or four years, but they have made absolutely no change from the old method except that when the malt is ready to be put upon the kiln it is carried up on elevators. That is the only change that I have seen in 40 years in the manufactur of malt. The place I have mentioned is a very fine new building, in which all the modern improvements could be made.

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Malt should be dried without contact with fumes.

4124. (*Dr. Whitelegge.*) Have you examined many malts recently—within the last few weeks?—Up to about the 17th or 18th December I examined 74 samples of malt, but I do not think I have examined any since then.

4125. Then you cannot say whether you have found recently that the malts have been free from arsenic?—I cannot, but the beer brewed is not yet free.

4126. We have been told that it is the practice of some brewers to require a certificate of the malt being free from arsenic?—As an example of that, I might say that this gentleman whose malt contained so much arsenic told the brewer in my presence, "I do not care; I will guarantee it to you." So certain was he that it did not contain arsenic that he said he would guarantee it. But of the value of a guarantee of that sort one can judge.

Small value of guarantees

Mr. Edward Sergeant, called; and Examined.

Mr. Sergeant.

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4127. (*Chairman.*) You are a Member of the Royal College of Surgeons, a Licentiate of the Royal College of Physicians, and Medical Officer of Health to the Lancashire County Council?—That is so.

4128. I think you would like to make a statement with regard to your district and with regard to your duties in connection with the office you hold from the Lancashire County Council?—The Administrative County of Lancaster, in the middle of last year, had an area of 1,038,269 acres, and a population estimated at 1,956,555. Within the county are 138 districts, including 20 municipal boroughs, 99 urban districts, and 19 rural districts. The whole of these districts, with the exception of the Boroughs of Accrington, Ashton-under-Lyne, Bacup, Blackpool, Clitheroe, Lancaster, Southport, and Warrington, are under the jurisdiction of the County Police, and the Superintendents of the various Police Divisions, 20 in number, are appointed inspectors under the sale of Food and Drugs Act for the purchase of samples for the purpose of analysis by the County Analysts, Dr. Campbell Brown and Mr. Collingwood Williams. The local authorities occasionally exercise their powers in purchasing samples of food for analysis, but as a rule this work is left entirely in the hands of the police. When the prevalence of arsenical poisoning among beer-drinkers was first recognised, Colonel Moorsom, Chief Constable of Lancashire, kindly permitted me to direct, through him, the purchase of beer samples, and the action to be taken on the discovery of contamination by the analysts. On the 23rd of November last my attention was specially drawn to the public danger by the statement which appeared in the press concerning the alarming prevalence among persons who drank beer in Manchester and Salford of symptoms of peripheral neuritis attributable to arsenic. The communication to the "British Medical Journal," November 24th, by Dr. Reynolds, as to the large number of cases which had been observed by him and several other medical men, left no doubt as to the serious nature of the epidemic. It did not take long to discover that in the County Districts of Lancashire many patients were suffering from symptoms of arsenical poisoning, due to the consumption of beer supplied by large brewers both outside and within the jurisdiction of the County Council; the prevalence of sickness and the severity of the symptoms being largely influenced by the amount of arsenic discoverable in the beers supplied to the consumers in the various localities. With few exceptions, only those beers were seriously affected in which the invert sugar manufactured by the well-known Liverpool firm (Messrs. Bostock and Co., Limited) had been used in

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the brewing, and the extent of the contamination varied considerably according to the proportion of this material to the malt of the brew. The amount of arsenic, in the form of arsenious acid or what is known as white arsenic, found to be present in the samples of beer submitted to the County Analysts, was certified as incapable of exact estimation in 50, and in 47 it varied from 1-15th to ⅔ grain per gallon. In one instance a sample of beer analysed by the Clinical Research Association showed the presence of 1·12 grains of arsenious acid per gallon, and this beer was productive of very marked symptoms of peripheral neuritis among the consumers. One death resulted, and subsequent examination of some of the viscera by Dr. Campbell Brown demonstrated the existence of arsenic in considerable quantities in the liver, spleen, and kidneys. Altogether 348 samples of beer supplied to retail houses from 175 breweries have been purchased, with the result given below:—

Quantities of arsenic in incriminated beer.

—	Number of Breweries.	Number of Samples taken.
Breweries supplying genuine beer -	108	251
Breweries supplying beer slightly arsenicated, but passable - -	36	52*
Breweries supplying beer containing an amount of arsenic injurious to health - - - - - -	31	45
Total - - -	175	348

The samples taken from "free houses" numbered 58; of these, 46 were found to be genuine, 8 slightly arsenicated but passable, and 4 contained an injurious amount of arsenic. Without exception, these contaminated beers had been obtained from outside brewers, and in no case was arsenic discovered in "home-brewed" beer. The police on the 27th of November commenced to take samples of beer in the various county divisions, and Table 1 appended shows that from that date to December 3rd inclusive 75 preliminary samples were taken, and 18, or 24 per cent., were found to contain arsenic to a serious extent. The information gained by the examination of these samples proved valuable; no legal action, however, resulted, as it was considered only fair to give brewers a reasonable time for taking precautions against the use of brewing materials in any way contaminated. From December 3rd to the end of February the police purchased 273 samples of beer for analysis, and of these 27, or 9·8 per cent., have been certified by the county analysts as seriously contaminated, that is, containing not less than a tenth of a grain of arsenic per gallon. In 24 instances prosecutions were instituted under section 6 of the Sale of Food and Drugs Act, 1875 (see Table I.), with the following results, viz.:—15 fines inflicted, varying from 20s. to £5, with costs; 4 adjourned, 2 withdrawn, and 3 dismissed. In explanation of the method of procedure adopted I may mention that on samples being submitted to the county analysts they first made a preliminary examination, and on the detection of arsenic in any sample they at once notified the police by wire; information was then conveyed to the beer-seller, who on his part communicated with the brewer, and further sale of the implicated beer was discontinued by sealing up the remaining barrels of the same brew found on the premises until complete analysis had been obtained. When an appreciable quantity of arsenic was finally certified the contents of the sealed barrels were promptly destroyed, and it is satisfactory to observe that no objection was raised to this drastic course of action, although in many instances legal proceedings were subsequently taken. The beers certified by the county analysts as "passable" were unsealed and allowed to be sold. During the period under notice, *i.e.*, November 27th to February 28th, the officials of the county either directly or indirectly secured the destruction of arsenicated beer contained in 5,313½ thirty-six gallon barrels, 22,680 pint and 12,395 half-pint bottles. Besides the above, a large quantity of beer was destroyed by brewers privately, and the bulk of beer contaminated to an appreciable degree was, in the course of a few days after the commencement of our action, removed from the possibility of sale.

Prosecutions under Sale of F. and D. Acts.

Destruction of arsenical beer.

In the early days of the beer scare the cause of contamination was chiefly attributed to the use of arsenicated glucose, and, although this source of trouble subsided, yet samples of beer known to be brewed from malt and hops only came under notice containing arsenic equivalent to 1-10th to 1-5th of a grain per gallon. Investigations carried out by chemists interested in this question soon showed that serious arsenical contamination could arise from imperfectly brushed malt as well as from yeast rendered impure during its growth. These views are now admitted by the brewers, and it is satisfactory to state that, subsequent to the 14th of last January, no case of contamination has come under notice sufficiently serious to give rise to legal action, although from that date to the end of February 101 samples were submitted to analysis. I think I shall have rather to alter my statement, because yesterday I received a letter from the public analyst, Dr. Campbell Brown, saying that he had found two other samples containing arsenic to a sufficient extent to indicate that a prosecution should take place. These samples were obtained on the 11th March. Having now got rid of beer recognised as distinctly dangerous in character the next point for consideration will be the action to be taken by sanitary authorities in regard to the sale of beer only slightly arsenicated. In my opinion it would be unsafe to allow the consumption of beer containing an amount of arsenic capable of estimation by the analyst. If it is a fact that the presence of arsenic is due to avoidable impurities which can be kept out of beer I see no reason why absolute purity should not be required. This position is already admitted by numerous brewers, who do not hesitate to freely advertise the purity of their beers. Unfortunately, some of these advertisements have proved misleading to the public, and the various methods of testing adopted by analysts have contributed to this result. It would be well, therefore, if analysts, with the assistance of Somerset House, could devise a recognised procedure for estimating the amount of arsenic in beer, and so avoid the conflicting want of agreement not uncommonly met with. It is extremely difficult to estimate with any degree of precision the amount of injury to health caused in this county by the consumption of poisoned beer. No doubt for some months before the symptoms of arsenical poisoning in beer drinkers were fully recognised in Manchester and Salford obscure cases, similar in character, not infrequently ending in death, were troubling medical men in various parts of the county. The earliest cases that have been made known to me are those referred to in a special report by Dr. Hitchon, Medical Officer of Health for Heywood, as occurring directly after Whitsuntide of last year. He also says that one was struck by the very unusual number of persons, especially men, who "were suffering from skin affections of the feet and hands; the feet and hands were red, swollen, and painful." The earliest death that I am aware of took place in the Wigan Infirmary, August 16th last, and is reported by Dr. Hannah, Medical Officer of Health, as having reference to a female who had been removed from his district (Ashton-in-Makerfield) on the recommendation of the private medical attendant (Dr. Latham). I have the reports here.

The communications received from medical officers of health show that in 37 of the total 138 districts within the Administrative County cases of arsenical poisoning have been observed, and information is given of 953 cases and 15 deaths, including 7 certified by the coroner after inquest. These do not, in my opinion, fully represent the total cases of poisoning in the county, and the wide variations in the district distribution as indicated by the returns are largely dependent on the views held by the local medical practitioners on the subject of beer poisoning. From my own investigations I feel justified in saying that many deaths from arsenical poisoning during the last half of 1900 have been registered as due to alcoholism, locomotor ataxy, Addison's disease, spinal sclerosis, disease of the liver, etc. This view I also give as explaining to some extent the great increase of deaths from causes largely dependent on alcohol which have occurred in the county during the six months ending December 31st last year, as

* Of the 52 samples certified as slightly arsenicated but passable, in 50 the amount of arsenic was incapable of estimation. Subsequent examination showed the presence of 1-15th of a grain of arsenic per gallon in two samples; the beer was destroyed in both instances, but no prosecution followed.

Mr. Sergeant. compared with the corresponding six months of 1899. See table below :—

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Returns from 124 of the Districts within the Administrative County.	Alcoholic Neuritis.	Peripheral Neuritis.	Multiple Neuritis.	Alcoholism.	Any other allied Diseases.	Total.
Deaths during Six Months :						
June to December 1900 -	4	14	5	54	41	118
June to December 1899 -	0	4	2	24	32	62
Increase in 1900 - -	4	10	3	30	9	56

The allied diseases are sclerosis and sundry others of that character, Addison's disease and so on, that were known by local medical practitioners as dependent largely on the consumption of beer, and probably due to arsenical poisoning. The total increase is 56. I have here, sir, the list of places where these have been returned from, and I have also spot maps, which show how they have been distributed. As illustrating the effect of highly arsenicated beer on the health of the consumer, I may mention the case of a brewer who on the 7th and 19th of September, 1900, was supplied with English glucose (Bostock's) in lieu of American glucose he had contracted for. The beers in which the English glucose had been used in the brewing were found to contain at least one grain of arsenic per gallon, and soon after delivery to the retail houses, about the third week in September, symptoms of arsenical poisoning occurred among the consumers. I am informed that frequently persons who drank from two to three pints of beer were attacked on the same day with nausea, vomiting, and diarrhœa, followed in one case by hæmatemesis. The more marked symptoms of arsenical neuritis appeared from the first week of October to the end of November, and I have had the opportunity of examining several of these cases. One man, whose illness commenced on the 13th of October, died on the 30th of November from decided arsenical poisoning.

I say from decided arsenical poisoning, because I attended the inquest, and with the private medical practitioner assisted in sending in sealed bottles the portions of the various viscera. Subsequently to that Dr. Campbell Brown, who examined them, discovered distinct traces of arsenic in various organs, so that there is no doubt as to that. I may also say that it was at first registered as locomotor ataxy, and subsequently the medical practitioner and I reported the death to the Coroner. It is one case of, I believe, many that have been returned as not due to the true cause. Of course, in this case it was not owing to any desire to cover up the cause of death, but simply to an error of diagnosis which might occur of course in any man's practice, in the early cases. Except in this fatal case the drinking of beer ceased, on the advice of the medical attendants, when serious symptoms developed. At the present time I understand that 50 per cent. of the persons attacked still suffer from the effects of the poisoning, and, with few exceptions, those who have returned to work still complain of nervousness, debility, and cardiac troubles. The men that I examined usually drank from two to four pints of beer daily, with an extra allowance towards the end of the week. Three females, whose beer consumption did not exceed one pint daily, came under notice, suffering from arsenical symptoms; in one case not more than half this amount of beer was consumed, and I calculate that the dose of arsenic taken would be equivalent to 1·20th of a grain per diem. It suggested to my mind that certain individauls, more particularly females, have shown an extreme susceptibility to the action of arsenic when taken in beer. Whether this is the full explanation, future investigations will decide. I may say that I have got a cask of the beer. If you at any time would like to have the beer for any further investigation I shall be very glad to send it you. This is the worst beer I have come across—the beer that I have spoken of as being so poisonous.

4129. The beer that had 1·12 grains per gallon?—Yes. It has been variously estimated at from one grain to 1·12, and even more than that. I may mention that 55 samples of jams, marmalade, and other sweets have been specially analysed by the county analysts, and none of these contained any arsenic. Quite recently 20 samples of baking yeast were analysed, and the county analysts report that, with possibly one exception, every one of the samples contained an exceedingly small trace of arsenic.

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4130. (*Professor Thorpe.*) Were the samples English yeasts?—They were taken indiscriminately. They were the ordinary yeasts purchased in shops for baking purposes. They would be like the yeasts that are called German yeasts—yeasts that are imported, and the ordinary yeasts that are sold in shops, the dry yeasts that you purchase. Arsenic in yeast.

4131. But you could get particulars no doubt?—Yes, we could get particulars.

4132. From your analyst?—I do not know that he would have any description beyond the particulars of the purchase, and the sample. I do not know that they would be able to say where they came from. They were purchased from small shopkeepers.

4133. Would they be known to be beer yeasts, or not?—I have inquired into that. I could not say that they were all beer yeasts. It was simply the fact that we got baking yeasts. They have been somewhat recently taken, and seeing that the trace of arsenic was so minute we have not considered it really desirable to go much further into the matter. We do not consider it is at all detrimental to health. It is simply a fact that these yeasts do contain a very minute trace or arsenic.

4134. You are aware, of course, that a very large proportion of imported yeast is derived from Dutch distilleries?—Yes.

4135. (*Chairman.*) You have not at the present moment any means of connecting these purchased yeasts with special breweries?—No. I do not think that they came from special breweries. It is simply that it occurred to us that the yeast might be contaminated, and that it would be interesting really to know the extent of the contamination in the same way that, as I mention further, we had under consideration certain non-alcoholic drinks. We have reason to believe that ginger beer, for instance, has proved dangerous to health, in consequence of the highly arsenicated yeasts which have been used in its manufacture. In fact, it has been stated to me by a gentleman, who has been very interested in this matter, and who made considerable investigations, that that is the explanation of symptoms of arsenical neuritis, that have appeared in a total abstainer who largely drank ginger beer. might contaminate ginger-beer.

4136. Therefore that ginger beer, which seems to have produced the symptoms you speak of, was made from local yeast?—That is so, and highly contaminated yeast. In the manufacture of the beer, Bostock's sugar had been used to the extent of 45 per cent. of the malt.

4137. And perhaps Bostock's materials had been further used in the manufacture of the ginger beer?—Well, I do not know that. I should not go so far as that. I am not aware that Bostock's sugar has been used in the manufacture of these non-alcoholic drinks.

4138. (*Dr. Whitelegge.*) Have you any analytical results with regard to this ginger-beer or the yeast?—No, I have not. It is simply a suspicion. We could not get that special ginger-beer. The explanation was given after some considerable thought, and it struck me that there was a substance of truth about it, or possible truth, and it showed the desirability of examining further into the non-alcoholic drinks. Beyond that I cannot go. In order to avoid a repetition of wholesale poisoning such as we have recently witnessed, it seems to me desirable that more attention should be paid to the carrying out of the Sale of Food and Drugs Acts which, in some respects, require amendment. All places used for the preparation of foods or drinks should be open to the inspection of the officers of the Sanitary Authority in whose district they may be established, and it should be competent for an officer to remove for the purpose of analysis any article used in the various operations carried on. Brewers should be required to declare on the entry sheet for the Excise *the whole of the materials* employed in the manufacture of their beers, and it should be incumbent on the proper officer of the Inland Revenue to have frequent analyses made of the various brewing materials in view of his action to obtain the absolute purity of the beer. I do not suggest that in the manufacture of beer the use of glucose to a moderate extent, say from 2 to 10 per cent. of its equivalent in malt is undesirable, but there is reason to believe that the use of from 35 to 45 per cent. Excise should know origin of brewing materials, which should be officially tested.

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of this material renders the beer less wholesome and more likely to produce dyspepsia and gastric disturbance. Some medical men attribute much sickness to the consumption of immature beers brewed one week and sold the next, and would prefer a malt and hop beer that has been fully matured. I have here the table which I have referred to, giving you the whole of the details. I may say that of the 60 samples of glucose which were examined 53 were found free from arsenic, and 7 were found containing arsenic. Four samples were found to be Bostock's and three samples were obtained from another firm. The name is there (*document handed to Chairman*), but perhaps it is not desirable to mention it because I do not know the amount of contamination. It may be of German manufacture, and it may be one that Mr. Estcourt spoke of.

Arsenic in German glucose.

4139. (*Professor Thorpe.*) Do you know the name?

(*Chairman.*) Yes, it is the name that Mr. Estcourt gave.

4140. (*Professor Thorpe.*) Do you know whether that German glucose is much used in your district?—I do not think that that is very much used, but I really cannot speak of that.

4141. Has it been long introduced, do you know? Can you give us any particulars?—I cannot say. I cannot give you any particulars. These samples were obtained by the superintendent indiscriminately.

4142. Is the amount of arsenic in that particular glucose given in your tables?—No, the amount is not given. I do not think it is given in the case of Bostock's either. These were simply preliminary examinations that were made to assist brewers, and the statement was made by the public analyst that the sample was either free from arsenic or contained arsenic, but the amount was not estimated.

Arsenic in beers not brewed from Bostock sugar.

4143. (*Chairman.*) You say "With few exceptions only those beers were seriously affected in which invert sugar manufactured by the well-known Liverpool firm (Messrs. Bostock and Co., Ltd.) had been used in the brewing." There were exceptions, then?—Yes. There were exceptions. I have here the particulars of the cases where we proceeded. Of the 24 cases, in 10 Bostock's sugar was used. The cases where the brewers had previously used Bostock's sugar but did not do so in the brew in question number seven, and glucose was obtained from another individual in one case. Whether he obtained it from Bostock's I do not know. I give the name here. Then we had six prosecutions where the beer was brewed from malt and hops only, and we have no history as to whether the brewers previously had used Bostock's glucose.

4144. Have you got an estimate of the amount of arsenic in those that were brewed from malt and hops only?—Yes, I have got particulars of the arsenic found in each estimtaion.

4145. Will you indicate which are those?—In the cases where Bostock's glucose was used the public analyst found three-fourths of a grain, two-thirds of a grain, two-thirds of a grain, ½ of a grain, ¼ of a grain, two-sevenths of a grain, one-ninth of a grain, one-ninth of a grain, one-ninth of a grain, and one-seventh of a grain. Then in the samples not containing Bostock's glucose, but brewed by people who had previously used Bostock's glucose, the amount of arsenic was as follows: ½ of a grain, ¼ of a grain, one-fifth of a grain, one-sixth of a grain, one-sixth of a grain, one-seventh of a grain, and one-tenth of a grain. Of course we could not prove that they had not used some of Bostock's sugar, but at any rate that is the information we obtained. Then with respect to the glucose purchased from the person in Shudehill, Manchester—he does not manufacture it, and where he got it I do not know. It is possible he got it from Bostock's; in that case there was found one-fifth of a grain in the beer. Then in the beer brewed from malt and hops only, of the 6 samples one contained one-fifth of a grain, another one-seventh of a grain, and the others, one-eighth of a grain, one-eighth of a grain, one-tenth of a grain, and one-tenth of a grain.

Quantities.

Arsenic in all-malt beer.

4146. So that they were nearly as arsenicated as the ones which were brewed with glucose?—Some of them, undoubtedly.

Breweries implicated in Lancashire.

4147. Were the brewers who brewed with the sugars which you have samples of Manchester and Salford brewers, or were they brewers in other parts of the county?—They were distributed all over the county. Some were well-known Manchester and Salford brewers, but there were brewers distributed all over the county.

4148. I see that in the map which you have given us showing the numbers attached, the cases are most numerous round Warrington, Darwen, and Huyton-with-Roby?—Yes, but there are also a good many at Heywood.

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(*Professor Thorpe.*) There are so many that the dots cover the area.

4149. (*Chairman.*) Yes, I see you have a cross there?—That is a death.

4150. I was going to ask whether you thought that these cases in the places I have mentioned were in connection with local breweries?—Yes, in the case of Heywood it was a local brewery; we prosecuted a retailer who sold beer from a local brewery, and they used Bostock's sugar. In the case of Gorton it is quite contigious to Manchester, and the conditions that affect Manchester would also affect Gorton. The brewers of Manchester and Salford supply the beer to Gorton.

4151. (*Dr. Whitelegge.*) You prosecuted the brewer, did you?—The brewer, indirectly. We prosecuted the retailer, but of course the brewer has always borne the brunt of the prosecution. It was a tied house, too.

4152. (*Chairman.*) Accrington; that would be a local brewery, too, would it not?—I cannot speak to that. I may say that Accrington is not policed by the county, and therefore I cannot speak with any confidence. It is one of the exceptions.

4153. And Ashton-in-Makerfield?—Ashton-in-Makerfield was influenced by the brewer who manufactured beer in the vicinity of Warrington, who has been spoken of several times.

4154. That would be one centre almost?—That is exactly the case. Earlestown and Warrington and all about there were the cases of one brewer, and all the cases that I came across were exceedingly acute cases. I have the beer of that brewer at the present time, and I must say that the brewer has given me every assistance in trying to get rid of the material, and in every case compensating and doing all that he possibly can. The glucose was given to him in lieu of American glucose. He was in absolute ignorance. That is an interesting case. One knows exactly when he used it, and exactly when the cases started, and as they were all characteristic cases of course it becomes of very considerable medical interest. Many of the cases are now under observation.

4155. He used American glucose?—No; he had Bostock's glucose given to him in lieu of the American glucose, which he had been using, and which he contracted to use. The American glucose had run out, and they said, "We are sending you some English glucose. This is really better," and so on; "You do not mind taking it?" He said, "No, I do not mind taking it; if it will do for me it is all right." But it was all wrong. I now place before you the key to the distinctive numbers of the breweries that I give on this table 1, so that there you have full particulars. (*Document handed to the Chairman.*)

4156-7. This is valuable to us, because it is showing that the incriminated beer was made over a wider area than we have yet got evidence from?—Yes, a very wide area. I may say that in one or two breweries where the arsenicated beer was very marked, the brewers withdrew their beers, and the public have never heard anything of them. They were fortunate in getting rid of their beer, and for some reason or other in the districts where they sold their beer, cases have either not occurred, or not been recognised.

4158. (*Professor Thorpe.*) What do you mean by saying they were fortunate in getting rid of their beer?—I think it is very fortunate to be able to escape the poisoning of the public. They took the matter in hand very early, and they rested neither night nor day until they had recovered every barrel of beer; and I may say that that specially refers to the gentleman whose beer I have spoken of as being so very bad.

Destruction of arsenical beer.

4159. (*Chairman.*) You are referring chiefly to the 5,313 barrels which you have noted in this further table you have shown us—the total quantity of beer known to you as having been destroyed under police supervision between December 10 and February 23 by 33 brewers (including some Manchester and Salford brewers) who supplied beer in Lancashire?—In my remarks just now I was referring specially to the Warrington brewery, because there this beer was bad, and I may say that the brewer himself was poisoned, and he spared no pains to get the beer removed, and it was removed. Until he could sell proper beer I do not think he sent any out of the brewery. That, of course, applies

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to other brewers at the same time. They acted very well in the matter. The total barrelage of beer given represents the material destroyed. You will see that that spreads over the whole county, and you will notice that in many districts mentioned, where large quantities of beer were got rid of there were no cases. You will observe this in the north of the county—for example, at Ulverston.

4160. The point you wish to draw attention to now, particularly, is that over a large portion of your district, in the north of the county, no cases or few cases of poisoning occurred, or were recognised owing to the very praiseworthy and rapid action of the brewers in withdrawing the beer, as soon as they knew it was contaminated?—I think so, and I also suggest that in some districts more attention, probably, has been paid to the recognising of cases of poisoning than in others. That has something to do with it.

4161. You have informed us that this destruction of beer was, in a sense, voluntary on the part of the brewers. You have no power to compel them?—A very large destruction of beer took place owing to the action of the brewers themselves. The beer I spoke of was destroyed at our suggestion. When it was certified that beer contained arsenic by a preliminary test—Reinsch's test—the police informed the retailers. On my instructions they told the retailers that they must seal up the remainder of the barrels of the brew that had been found to be wrong, and they sealed them up accordingly. Whether the police had the right or not to act as they did does not matter. They simply said, "These barrels must be sealed up. The people must not be poisoned." And the retailers agreed to that. We did not trouble ourselves as to whether it was in accordance with the law or not.

4162. As to whether you had legal power or not?—We did not consider it. Our efforts continued until we could stop the sale of the poisonous beer. The procedure was not objected to, and, when the beer was found distinctly wrong, it was destroyed. No difficulty was experienced in destroying it. It was destroyed willingly. When it was found passable the seal was removed, and it was sold.

4163. (*Professor Thorpe.*) In other words, you laid an embargo upon the beer until you got further information?—Exactly, and if there had been any difficulty in getting rid of this beer, we should have had to consider whether we could not seize it, under sections of the Public Health Act, or the Public Health Acts Amendment Act, as food unfit for human consumption. We should have had to consider that, I suppose, in case of obstruction, but we had not that difficulty to encounter.

4164. (*Chairman.*) You say, "In my opinion it would be unsafe to allow the consumption of beer containing an amount of arsenic capable of estimation by the analyst." Would you explain a little further what you mean? Do you mean by that an estimation of the arsenic in a given quantity of beer, or that he may use as much beer as he likes?—Of course we know it would be capable of estimation, taking a very large quantity, but I am speaking now of the ordinary samples that we send. We have six quarts of beer divided into three parts, each part being two quarts of beer. I presume if you take a huge quantity of sea water, you might detect a certain amount of gold in it, and the same with beer. Any beer, I think, would scarcely escape having a minute quantity of arsenic; but if, in the ordinary practical sample that is sent to an analyst, he finds arsenic as a trace, and, as Dr. Campbell Brown said, not capable of estimation, I do not think that we need interfere in the matter.

4165. That is to say in a quart of beer?—No, two quarts of beer.

4166. But practically if he had two quarts to deal with he would probably only use one for examination at a time?—Well, I know that there is a very delicate method of ascertaining the arsenic.

4167. I am not pressing you about that?—I should think you are right in saying that a quart would be taken.

4168. If the presence of arsenic was not detectable in a quart, you would be satisfied with regard to the safety of the public?—I am afraid I had not in my mind the amount of beer that should be taken. I think amongst chemists it is usual in examining water, or other articles, to say that a certain mineral, or whatever it may be, is present as a trace. Well, if it is a trace, I presume that that is not capable of estimation, unless you make a special estimation of a large quantity. Of course, if you do get a large quantity, no doubt you would be able to assess it, but it is very minute. It would be a trace, and even if you assess it, it would be a very minute fraction.

4169. The object of my question is rather to gain from you information, if I can, as to the quantity of beer that you thought ought to be used by the analyst for this examination?—I am afraid I would not like to specify that. I would not like to specify the amount that should be found. I do not think the beer should contain arsenic at all really, beyond the merest trace. In the samples we have obtained for analysis we found 75 per cent. to be genuine, and if 75 per cent. are genuine I do not see why we should not have 100 per cent. genuine.

4170. They are only genuine upon the sample tried, which is a limited quantity of beer, and what I wanted rather to get your opinion upon was whether you thought that quantity was sufficient in safeguarding the public?—I think so, yes. It has been suggested by Dr. Campbell Brown that if you analyse the air of manufacturing towns sufficiently long in sufficient volumes you might detect particles of arsenic. There is no doubt about that. But then for practical purposes the air of a town is free from arsenic.

4171. It is your opinion then, as a medical officer of health, that the public health would be sufficiently safeguarded if no arsenic was detectable in a quart of beer?—I should think that that would be the case. I may say that in the prosecutions which have been instituted we have not taken action unless the amount of arsenic has been equal to one-tenth of a grain or more. Upon a less quantity than that we have not taken proceedings, because our desire was to remove all that we considered actually dangerous beers. After the one-tenth of a grain we come upon debateable ground as to the amount of arsenic. Probably we shall have to proceed further and take action where the amount is very considerably less than that, but at present, so far, our energies have been directed to removing actually dangerous stuff. We consider the beer at the present time is probably as good as it has been for years, if not better.

Quantity of arsenic in beer which has entailed prosecution.

4172. (*Professor Thorpe.*) I venture to think that all you mean to imply is that any limitation must have reference to a definite quantity of beer, the absence or presence of arsenic in which is to be ascertained by some definite method?—By some definite method. That is by a standard method which should be adopted.

4173. Otherwise your statement is a mere relative statement—relative to the amount taken and the character of the test which should be applied?—Yes.

4174. (*Dr. Whitelegge.*) Who fixed that standard of one-tenth which formed the mark for the prosecution?—I rather suggested it myself. I thought we should have quite enough to do in getting rid of the beers containing one-tenth or more, and that beyond that the danger was not so acute.

4175. You do not say that beer containing one-fifteenth of a grain per gallon is not dangerous to public health?—I may say that whenever we found arsenic in quantities capable of estimation we had the beer destroyed, but I may say we did not take legal action. It was invariably destroyed where we found arsenic in the beer capable of estimation, even to one-fifteenth of a grain.

greater than that entailing destruction only.

4176. You did consider it dangerous to health, but you did not direct a prosecution?—We considered it ought not to be drunk, at any rate, but we did not think it was desirable to haul them up in the Courts of Justice and punish them for a matter of that kind, because we know perfectly well that many of the questions affecting brewers were sprung upon them subsequently to finding saccharine and glucose impregnated with arsenic, for instance the question of malt and also the question of yeast.

4177. You distinguish between "beer slightly arsenicated but passable," and "beer containing an amount of arsenic injurious to health." Is that to be understood as based upon the one-tenth of a grain standard?—Yes.

4178. (*Professor Thorpe.*) The one-tenth of a grain is ascertained for you by a particular method used by Dr. Campbell Brown?—Yes. You see the beers were destroyed as far as possible when they contained an amount of arsenic capable of estimation.

4179. (*Dr. Whitelegge.*) Then one-tenth or more you would regard as more actively injurious to health?—Exactly.

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4180. Was it with your approval that the beer laid under embargo and found on analysis not to contain a high amount of arsenic was set free?—It was with my approval, and it was mainly on the suggestion of the public analyst, who occasionally on a certificate stated that the beer was passable and might be sold. I may say that these certificates have been sent to the superintendents first hand, and beers were allowed to be sold, without any reference to me very often. The County Analyst occasionally gave on his certificate as an observation: "This beer may be sold."

4181. What standard did you understand him to be following in certifying some kinds of beer to be passable—the one-tenth of a grain?—I do not know; he would not say that one-tenth of a grain would be passable; they would have to be less than that.

4182. Do you know how much?—No, I am afraid not. I should think that in many of the early cases he would not really assess the amount. He would consider that it was not capable of estimation. But he will be able to speak of that himself.

4183. So the term used by the County Analyst is to be taken in a different sense to that in the table above. I understood from you that we are to take the term "passable" as meaning containing not more than one-tenth of a grain?—I think I have already mentioned about one-fifteenth of a grain.

4184. We certainly should not consider one-fifteenth of a grain passable, or anything like it. The amount of arsenic found to be present in the samples of beer submitted to the County Analyst was certified as incapable of exact estimation in 52. Well, the 52 would be termed "passable" beers. Then in 45 it varied from one-fifteenth to $\frac{2}{3}$ of a grain. All those beers were destroyed. When it was one-tenth or more you prosecuted. That is the way I took it. Then to make it quite clear, in the table (Appendix 10, Table I.) are we to understand that "passable" means one-tenth or less?—No; I say "incapable of exact estimation 52." Then there were a certain number that were genuine, and in 45 the amount was found to be one-fifteenth to $\frac{2}{3}$. Where it was incapable of estimation—that is, the 52—it was allowed to be consumed, but where it was found in poisonous quantities—we will say one-fifteenth of a grain or even less than that—if it were capable of estimation, it was destroyed. But we did not prosecute unless we found one-tenth of a grain in the beer.

4185. Do you mind applying that to the table? "Genuine beer," I suppose, means beer containing no arsenic?—Yes.

4186. "Beer slightly arsenicated but passable," what does that mean?—That "slightly arsenicated but passable" would be beer containing arsenic in quantities not estimated.

4187. But none of them approach, as I understand you now, one-tenth of a grain per gallon?—Except in two instances none of them approach that.

4188. Then the third category, "containing an amount of arsenic injurious to health"?—That is containing one-tenth or more.

4189. I understand that the second list—those that are passable—do not approach the one-tenth?—Yes, that is so.

4190. So those you regard as injurious?—The "breweries supplying beer containing an amount of arsenic injurious to health" would number 31.

4191. You cannot give me the ratio of the number of grains per gallon on which the distinction between class 2 and class 3 is based?—Subsequent to December 3rd there were 24 prosecutions. The total number of samples containing a quantity of arsenic injurious to health was 45, but prosecutions only took place subsequent to a certain date. Previous to December 4th we had a number of cases that were seriously arsenicated where no legal action was taken.

4192. That I follow, but I rather wanted to obtain from you, if you could give it me, the point at which the line of demarcation was drawn?—What I say is that we prosecuted if the beer contained 1-10th of a grain or more of arsenic, and if it contained, we will say, 1-20th or 1-15th we certainly recommended the destruction of the beer, but did not institute legal proceedings. If it contained a minute quantity of arsenic I suppose that Dr. Campbell Brown would not go to the trouble of assessing the exact amount. He would say this, "From our preliminary analysis we consider that the amount is merely a trace, and we consider the beer passable." That is really the position we took up on general lines.

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4193. (*Professor Thorpe.*) But Dr. Campbell Brown surely was singular in that respect. I am not aware of any public analyst having taken upon himself to determine what should be the limit in amount of arsenic; in other words, to determine when it became injurious to health, and when it was not?—He will be able to explain his action I daresay. I am simply saying what was done and what the character was of the certificates received. I have got one here, and you will see there exactly what Dr. Campbell Brown stated. There you have his exact statement, and you will be able to see what he has said. (*Document handed to Chairman.*)

4194. (*Chairman.*) The quantities do not seem in all cases to be given. It states "serious quantity of arsenic"?—I may say the certificates at first contained "serious quantity of arsenic," and then we had to wait for subsequent analysis to designate the amount of arsenic present.

4195. (*Professor Thorpe.*) That was explained to us by Dr. Reid; that it was necessary to take prompt action to divide the beers; but I do not recognise that it was within his functions to determine this question?—I do not say anything about that, I simply had to act on what I received from the analyst, and we could not do any more. If the analyst reported or certified that a certain beer was passable, you quite understand that I could not take any other action than allow it to be passed. In fact, as I say, the superintendent first received the certificate, and he acted upon the certificate at once.

4196. (*Dr. Whitelegge.*) Did the certificate come to you or go to the superintendent of police?—The superintendent of police, the one who purchased the sample, got it.

4197. (*Professor Thorpe.*) Do you know that Dr. Campbell Brown was required to give a certificate in those terms?—If you would allow me, I would rather not explain as to the terms which were used by Dr. Campbell Brown. I have here the subsequent certificate that he used. You will see the form of certificate, and probably you will form an opinion yourself as to what terms should be used. That is the form. It happens to be one that I have got.

Decision County Council officials prosecut

4198. (*Dr. Whitelegge.*) When the superintendent or inspector received this report, did he come to you for instructions?—No. When the certificate stated that the arsenic present was serious in quantity he communicated with the Clerk of the County, who discussed the matter with me, and we decided what action should be taken. In those cases where the amount was serious or stated to be injurious to health, we took, subsequent to December 4th, legal action, and in many of the early cases we had to wait for the complete analysis showing the amount of arsenic actually present.

4199. This is not a final certificate, I presume, is it?—Yes. This is a final certificate.

4200. Upon which proceedings would be taken?—We took proceedings on that.

4201. (*Professor Thorpe.*) Was no other certificate presented eventually?—That is the certificate on which we took action.

4202. (*Dr. Whitelegge.*) Without the quantity being stated?—The quantity was stated subsequently. On application on the part of the defendant in the case we gave further information. That, I must say, has given rise to some difficulties in our prosecutions, but seeing that the county analyst received hundreds of samples, you can quite understand that there would be a difficulty in giving at once the amount of arsenic present in each case. Of course, our chief action was taken on the preliminary examination, when a wire was sent to us stating that it contained either a slight amount of arsenic or that it contained a large quantity of arsenic. On receipt of wire we acted, and promptly, too. That was the chief action, and very important in the early cases, that is, from November 27th to December 4th.

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4203-4. What do you mean by "took action"? Did you lay an embargo on the beer?—As soon as we got a wire from the County Analyst that a serious quantity of arsenic was present, or that arsenic was present in quantity at all, we telephoned to the superintendent of police, and told him sample number so-and-so contained arsenic, and that he must proceed to the retailer, and see that the barrels affected were sealed up. That was

done at once, pending the action necessitated by the complete analysis.

4205. Legal proceedings, you mean, would probably ensue in that case?—Legal proceedings ensued in the cases where the result showed that a serious quantity of arsenic was present.

4206. This is signed by both analysts?—There are two appointed analysts.

4207. Acting together?—Yes.

4208. Not for different parts of the county?—No, they act together. They are both county analysts.

4209. Have you any staff of your own for the purposes of the administration of the Sale of Food and Drugs Act?—No, I have no staff under my own express direction, but I have had the assistance of the police, and it is very valuable, because I have been able to cover the whole county; without the police I probably should have wanted a very large army of inspectors. There is one inspector, who is appointed by the Standing Joint Committee, who devotes his attention chiefly, I think, to the purchase of samples of milk, and butter, and cheese—chiefly agricultural produce.

4210. Does he act under your direction in any way?—He does not. But indirectly; if I want anything doing I can always send the police, as in this matter. The chief constable kindly allows the direction of affairs in matters relating to the Sale of Food and Drugs Act to be entirely in my hands.

4211. Then you have on former occasions taken part in the administration of the Sale of Food and Drugs Act?—Undoubtedly; in fact, one of my duties is to advise and supervise the action taken under the Sale of Food and Drugs Act.

4212. Were inquests held in the cases which ended fatally?—I think I have information of two inquests.

4213. Do you say there were not inquests in the other cases?—One inquest was held, as I have previously mentioned, at my instigation in the neighbourhood of Warrington, and in the other case an inquest was held at Gorton.

4214. And the coroners in the other districts did not consider it necessary to hold inquests?—I cannot give the reason; I am not aware at present that inquests were held.*

4215. You mentioned a fatal case as having taken place at Wigan on August 16th?—Yes.

4216. Was that at the time known to be an arsenical poisoning case?—I do not think it was known at the time, but the doctor who had it removed was very much startled, as doctors were in other places, by the curious symptoms that affected a number of his patients. This patient was removed, and she died of arsenical poisoning. She had all the symptoms of arsenical poisoning, and her habits were of such a character as would probably induce one to assume that she was affected by the drinking of beer. She died from peripheral neuritis, but the doctor now has no hesitation in saying that she died from arsenical poisoning. That is in the light of subsequent events.

4217. (*Chairman.*) When did Dr. Hitchon communicate with you?—I have got here the report. This is the report I received from him on the subject. (*Handing in report to Chairman.*) It was subsequent really to the information I got from other districts.

4218. I see this is the 29th November?—It was in consequence of a letter that I wrote to the medical officers of health he sent me that report. It is a copy of a report he presented to his committee.

4219. I mean the earliest cases that have been made known to you are those referred to in a special report by Dr. Hitchon, the medical officer of health for Heywood. He did not communicate with you?—Not at that time.

4220. Not until after the connection between the epidemic and arsenic was known?—That is so. I had no information in the early inception of this.

4221. So that, although there were in his district an unusual number of persons suffering from affections of the skin, and feet and hands—"the feet and hands were red, swollen and painful"—that had not aroused suspicion of anything in the shape of poison?—Not at that time. I think two or three, including Dr. Hitchon, and I may say, Dr. Latham, of Ashton-in-Makerfield, and Dr. Mouncey, of Earlestown, were considering the matter, and coming to a conclusion, when the matter was brought prominently forward in Manchester about the 23rd November.

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4222. So that he, as a Medical Officer of Health for the district, did not refer to you until the connection between arsenic and beer had come forward in Manchester?—Yes, that is so. This is the letter I wrote to many medical officers on the 28th November (*producing letter*).

4223. Thank you, but I wish to get, if I can, more information as to the commencement of anything being suspected. You have not had your attention drawn, since you have been Medical Officer of Health, to an increase in the number of deaths from what I may term nervous diseases?—Not previous to this matter.

4224. Not in previous years. They have not been gradually increasing?—I have not noticed it. I got this information that I tabulate as to the number of deaths, as a result of special communications sent to local medical officers of health. You have it in detail

4225. That only alludes to two years. I was asking if you could give me any information for, say, five years back?—I have not got that information. I could get it, but it has not been obtained. It was in the early inception of the affair, and I thought this information would be of value. I only asked for this information. in the MSS., and I have already given a summary (Appendix 10, Table II.).

Arsenic poisoning attributed to Addison's disease, locomotor ataxy, and spinal sclerosis.

4226. You say "From my own investigation I felt justified in saying that many deaths from arsenical poisoning during the last half of 1900 have been registered as due to alcoholism, locomotor ataxy, Addison's disease, and spinal sclerosis," and so on. Have you any idea of the number of cases of Addison's disease which have been registered in that time, because it is a rare disease?—It would necessitate a prolonged investigation in various districts, but I can mention several cases, sufficient to cause me to believe what I say here. In Gorton, for instance, there are two or three cases of Addison's disease, distinctly reported. Then, as I told you, there was a case of locomotor ataxy that came under my notice, and also spinal sclerosis, and diseases of the liver. All those causes have been given as the cause of death; and local medical officers have told me that they considered such cases ought to be returned as caused by arsenical poisoning, because of their own knowledge they have been aware that such persons have been large consumers of beer, and so on. In fact, I have been requested to put in the list of deaths as directly due to arsenical poisoning cases which were not returned to the Registrar as such.

4227. My point is this rather. Have the number of cases of death from Addison's disease, not during the last year, but during the last five years, been higher than the average during the preceding five?—I cannot speak of that. I have not the information. My information is really from general examination, and I could not carry out a complete system of localised investigations because being such a big county it is impossible for one individual to administer this, and also make careful medical examinations. If I could have had two or three medical assistants I should have been able to do it, but as I am alone it would be really impossible for me to do it.

4228. I thought you might have the death mortality returns sent you?—I do not get the detailed deaths from various causes. In fact, I have not been accustomed to receive the deaths from alcoholism and the other causes which are mentioned here.

4229. Some of these cases would hardly be likely to be confounded with arsenical poisoning, would they; for instance, spinal sclerosis?—I can give you the name of the doctor who asserted to me that he had one case that had been given as due to this cause, spinal sclerosis, and in his opinion it ought to have been poisoning from arsenic. He gave it to me as one death which ought to have been included in the list that I have given you here—the list of deaths distinctly due to arsenical poisoning.

4230. Locomotor ataxy?—I can speak of that from definite knowledge, because in the case where I suggested a post-mortem should take place, the cause of death was returned as locomotor ataxy. I attended the post-mortem, and as I tell you, the liver, the spleen and the

* *Note by Witness.*—Returns subsequently received from medical officers of health showed that five additional inquests had been held.

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kidneys were found to contain considerable quantities of arsenic.

4231. I suppose a man with locomotor ataxy might be a big beer-drinker?—There were distinctly symptoms of arsenical poisoning—most characteristic symptoms. He drank the beer that others did in the same neighbourhood, next door, and in adjoining houses, and they were suffering from arsenical poisoning. He drank this beer, and during the time he was ill he also drank the beer, and he died from drinking the beer; and when he was dead we found arsenic in the various organs that I have spoken of. That was returned as locomotor ataxy.

4232. (*Dr. Whitelegge.*) Is that one of your 12 cases?* —That is one of the fatal cases where inquests took place.

4233. (*Chairman.*) I am not in the least questioning what you wish to say, but surely the symptoms which have been described to us over and over again are very far distant from the ordinary symptoms of locomotor ataxy?—I think that the death, if I remember, took place somewhat early in the affair, and things had not proceeded sufficiently for the medical man to diagnose it as due to arsenical poisoning. He died on the 30th November, and that was rather early in the affair. I cannot explain, and I am not going to suggest anything as to what influenced the medical attendant in his diagnosis. There are various reasons for medical men not giving the true cause of death in their certificates. I do not say that it is so in the case mentioned, but I fancy in certificates the desire not to hurt the feelings of members of the family has perhaps induced certain medical men to give a cause of death which may not be so unpleasant to the relatives as arsenical poisoning. I believe that has influenced medical men. There are many men who rather jib at the idea of giving the cause of death as, we will say, alcoholism.

4234. I perfectly follow it. I perfectly understand that a number of deaths due to arsenical poisoning might have been recorded as due to other causes, but I also wish to guard against thinking that it is not impossible nervous symptoms perfectly unassociated with arsenic are now put down to arsenic. Those are the two things that were passing in my mind?—I can speak definitely of one case, and that is one of locomotor ataxy. I think that is proved by the subsequent finding of arsenic in the various organs. That is one definite case that I can speak of; with regard to the other cases I can give you the name of the medical men who largely influenced me in the statement that I made there, if you care to have his name.

Statistics obtained by Lancashire County Council incomplete as regards several districts in the County.

4235. (*Dr. Whitelegge.*) You told us of 12 deaths* and said inquests were held in two cases. In the other ten, are we to understand that arsenic was mentioned in the certificate, or are they merely cases which, having regard to all the circumstances, you now put down to arsenic?—I sent out a form to various medical officers of health in the county, and asked them to give me information as to the deaths from certain causes, the cases from arsenical poisoning, and the deaths. This is the list of the cases which were returned, and they give me those deaths without any special information in many cases.

4236. Did you obtain returns from all the medical officers of health?—I sent to all of them.

4237. And you got returns from them?—I got returns from a certain number. I think the number is 124. Unfortunately the others did not send me the returns, the assumption being that there were no cases in those districts. But in order to get the returns from the districts it necessitated writing many times, and sending telegrams, and in the case of the balance I could not get the returns.

4238. And you were obliged to make up the returns from those you got?—I was obliged to make up the returns from 124 districts.

4239. Do you know by what means the medical officers of health in the districts from which you have returns obtained information?—I cannot speak specifically on that point. In fact we have had so much difficulty in getting returns. I thought I might possibly ask for more information than many of them would give, and rather stopped asking for it. In fact, in one case the medical officer asked me who was going to pay him for getting this information, so I thought I was getting very near to the end of my tether on that matter.

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4240. (*Professor Thorpe.*) Dr. Whitelegge pressed you somewhat to give your own idea, so far as you are able to form one, of what was connoted with the terms used by the public analysts in their certificate—the terms such as "serious," "much," "little," "passable." Those were terms which were employed in the certificates in the first instance?—Yes.

Quantity of arsenic in beer entailing prosecution

4241. And you subsequently got further information of a quantitative nature following on those certificates? —Yes.

4242. When you took an action into court, upon what certificate did you proceed?—That represents the sort of certificate that I proceeded upon.

4243. The certificate that you got in the first instance? —No, not in the first instance. The first was a wire, which stated, "Arsenic is in No. so and so," giving the number of the samples, or of the one sample, as the case might be. In that case we communicated with the superintendent who purchased the samples.

4244. I have been trying to get from the returns which you have been so good as to present here, what quantitative idea would be attached to these terms. If I have followed you correctly, it seems that your action has been wholly based upon a qualitative indication in the first instance. I am speaking of the embargo you laid?—Yes, the qualitative; that is so.

4245. It was entirely directed to a qualitative indication?—Yes. In fact, in the early cases I do not think a quantitative analysis was made really.

4246. I notice with regard to a certain sample which was purchased on the 4th of December that the analyst reported that it contained "much arsenic"?—Yes.

4247. The number of the sample is 873. You proceeded upon that, and the man was fined £5 and costs? —Yes.

4248. On December 4th, the same day in fact, there was another report sent to you in which it was said that the beer contained a small quantity of arsenic. That turned out to be as much as one-sixth of a grain?—What number is that that you refer to?

4249. That is No. 651?—That contained a quantity of arsenic—one-sixth of a grain.

4250. Is that the quantitative idea that you think we ought to associate with these term? Here you have "much arsenic," where you have one-seventh of a grain, and here it is reported as "a small quantity," and it is afterwards reported as one-sixth of a grain?—You see the information that I received. I did my best to work on the information that I had. I was not responsible for the information that was sent to me. You have here the first results of the examination; and then the second results giving the exact amount. We did our best. Of course there may have been correspondence or wires and so on in these cases where there was a little doubt as to what was meant by "much," or "a small quantity," or "contained arsenic," without any qualifying word. We had in some cases to wire or to write. I cannot in individual cases give you the information. No doubt I had to further communicate with the county analyst on many of these samples, but I myself do not wish to explain why in one case the analyst should say simply that it contained arsenic, and in another that it contains much arsenic, and in another a serious quantity of arsenic. I do not propose to explain that. It is possible that Dr. Campbell Brown may appear before you and be able to explain perhaps the reasons for that.

4251. Yes, but it would appear from the table that you prepared for us that these terms, "much," "serious," "little," and "small," really do not connote any quantitative amounts?—We went on the broad principle that if it contained arsenic action should be taken, and in the cases I have mentioned before, where it was serious, that was sufficient to take action, without any further reference to him. In many cases we had to communicate with the analyst for further information. The tables have been prepared from information contained in final certificates.

4252. (*Chairman.*) In fact your object was to secure rapidity of action, and not wait until you had definitely finished your analysis?—That is so.

4253. Therefore, I should be right in imagining that this particular sample, 651, which was first reported as

* *Note by Witness.*—Returns subsequently received from Medical Officers of Health showed that three additional deaths (making 15) had been attributed to arsenical poisoning.

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"a small quantity of arsenic," has been subsequently examined, and turned out to be a very much more contaminated sample?—That is so.

4254. (*Professor Thorpe.*) But the point I wish to put is that the course of justice was somewhat prejudiced by the use of these terms in a somewhat vague sense?—You see a case was not heard until we had a definite amount to give.

4255. (*Chairman.*) The action taken upon these vague statements (if I may use that phrase), was that of impounding the beer, and the action of prosecuting was not taken until after the quantities had been estimated?—I could not say that that was the case in all cases, but as a rule we waited for the exact amount. Of course, under the Sale of Food and Drugs Act, the action must be taken under a certain number of days—28 days, I think.

4256. (*Professor Thorpe.*) What it means is that before the case was ripe for hearing, you had got the quantitative information?—Exactly; that is so. Of course, if we discovered, we will say, that there was less contamination than we at first contemplated, the case would be withdrawn. In one or two cases we did withdraw.

4257. (*Chairman.*) In such a case as this, for instance, between the serving of this notice and the action coming on, probably a second examination for the purpose of discerning the quantity had been made?—Undoubtedly.

4258. And if you had found it was a very small quantity, you would have withdrawn the action?—Yes, if it had been very small; if it had been less than one-tenth of a grain we should have withdrawn.

4259. But if you found it amounted to anything like one-fifteenth or one-tenth of a grain, you would have gone on with your action?—Not one-fifteenth.

4260. But one-tenth?—Yes. In this case, No. 227, where certain action was taken, it says, "Contains a serious quantity of arsenic." That is the first notice we have about it. Then the subsequent analysis shows the presence of two-thirds of a grain per gallon.

4261. (*Chairman.*) What are the reasons of the medical men, with whom you have been in communication, which lead you to think that much sickness could arise from the consumption of immature beers brewed one week, and sold the next?—The assumption of some medical men that I know, and who have been heard in this matter before, is this; that these glucose beers are sold before what is called the cask fermentation takes place, and their opinion is that when these beers are drunk the fermentation may take place in the stomach, and account for some of the vomiting that takes place amongst consumers, as is well known amongst retailers of beer—sudden vomiting and very often gastric symptoms that cause them to seek the advice of a medical man about. That is the impression. They consider that years ago when beers were properly matured and sold after what is called secondary or cask fermentation, the same amount of violent sickness was not induced as in the case of immature beers. I observe myself these men have a considerable amount of sickness, and I rely upon old practitioners, who seem to be very strong about it. In the course of my investigations they urged me to bring this matter forward.

4262. The fact that vomiting is quickly excited would be rather favourable to their escape from subsequent trouble?—No. I do not think it would, because they return after their vomiting to further beer. I have seen that myself, and it may be seen near many of these public-houses on a Sunday. You will find a good many beer drinkers waiting for the public-house to open, and occasionally you will find one man suddenly emitting large quantities of beer upon the pavement, and another man will follow suit. As soon as the public-house opens they troop into it and drink further large quantities of beer, and risk what the further effect may be upon their stomachs. That is what I have noticed. They do not really give it up. In fact, many of the beer drinkers who were poisoned with arsenic, although they have not recovered, have returned to their beer-drinking. They think the conditions now are safe, and they can do it with greater satisfaction to themselves, and with less danger to health, too. Holding such views, I have not a good opinion of many of these people who drink beer. May I mention one thing? That is with regard to the passage where I say, that difficulties have arisen owing to the difference of views with respect to the character of beer. A brewer has just said that if samples of a certain beer were distributed to half-a-dozen analysts you would have probably half-a-dozen opinions respecting it. I do not know whether it is so great as that, but at any rate the difference has been considerable. We prosecuted in two or three cases where a certificate had been openly exhibited in the retailer's house, that the beer was brewed from malt and hops, and that it had been examined by certain well-known analysts, and found to be free from arsenic. Two or three prosecutions have taken place under those circumstances. On another occasion we found attached to the barrel this document here (*producing document*), which privately you may look at, where it is stated that the brew has been examined and found to be free from arsenic. We had to prosecute, and there was no objection taken to the result of the analysis by the county analysts. In another case the difference among analysts was very marked. A brewer came to me with respect to his beer that had been found by the county analyst to contain one-tenth of a grain of arsenic. He stated to me distinctly, and I believed him, that the beer was made from malt and hops only, and that being the case I myself had very great hesitation in suggesting that a prosecution should take place. A further examination was made by the county analyst, and he stated that undoubtedly it contained one-tenth of a grain of arsenic per gallon. When the case came before the magistrates it was arranged that the remaining sample should be sent to Somerset House. The sample was sent to Somerset House, and in due course the beer was certified containing one-hundredth of a grain. We had also obtained from the brewer a certificate from an analyst of repute showing that it contained one-eightieth of a grain, and another where it said that it contained one-hundredth of a grain. Yesterday I got a certificate from a well-known chemist, Dr. Stevenson, who said the sample showed one-sixth of a grain. So you have men of the highest eminence differing. I have certificates from three analysts, and then there is Dr. Campbell Brown four, and Somerset House five, and these good people all differ. That I think shows the desirability of having a uniform system or mode of procedure which is defined and specified, so that an analyst can carry it out with a better chance of agreeing with his confrères.

Conflicting results obtained by different analysts with arsenical beer.

4263. I think it is quite possible that these differences may arise from the bottles into which these samples are placed. I find here that Dr. Stevenson has only had sent to him about one-fifth of a pint, and that probably may have been put into a bottle very imperfectly cleaned. It is quite clear that it is exceedingly undesirable that there should be these discrepancies, but it seems to me that discrepancies such as those you have mentioned depend upon the way the samples are taken, probably, rather than upon the analysis the chemist makes?—I do not think that would be the explanation, because Dr. Campbell Brown sent to Dr. Stevenson the sample, and I think, presumably, he would send it in a clean bottle not containing arsenic.

4264. (*Professor Thorpe.*) But could you attach the same amount of importance to determinations that were made upon one-fifth of a pint, as you would to one that was made upon a quart?—I am only giving the result. If Dr. Stevenson thinks himself justified in saying that this contains one-sixth I do not wish to say whether it is sufficient or insufficient. He, as you know, is an expert in poisons, and very often in criminal cases of great importance he has to give evidence, and on his opinion results very often of life or death depend. And therefore I simply take what he says, that he finds a certain amount, and he does not say the amount that was sent to him was insufficient to allow of a proper analysis. We have had another case of a similar character. In fact, we have had many cases, and it has been suggested that the upper part of the barrel is more free from arsenic than the lower part of the barrel. That is another suggestion that is very unpleasant, because the lower part of the barrel might be very poisonous, and necessitate a person who is going to indulge in a pint of beer asking whether it was from the upper part of the barrel or the lower part of the barrel before he drank it.

May be more arsenic in lower part of a barrel.

Mr. FRANK SCUDDER called and examined.

Mr. F. Scudder.

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4265. (*Chairman.*) You are, I think, a consulting chemist practising in Manchester, and chief assistant to Sir Henry Roscoe?—Yes.

4266. You have had considerable experience of testing for arsenic before this recent epidemic?—Yes, especially when I was associated with the late Dr. Angus Smith in his work as inspector under the Alkali Acts, testing for arsenic in coal smoke, flue gases, and in gases given off in glass houses, and in the air and coal smoke of Castleford. Also in poisoning cases, and in the examination of wall papers for arsenic.

4267. Since the epidemic have you analysed beers and beer materials for your own interest, and also tested samples for brewers?—Yes, and also for the consumers of beer—private individuals.

"Minimetric" method of estimating arsenic in beer by comparison of Marsh mirrors.

4268. These experiments, together with your former experiences, have led you to form conclusions as to the methods of estimating arsenic in small quantities in beer and beer materials?—Yes, I soon found out that it was a most difficult problem to get reliable and trustworthy quantitative results. It was comparatively easy to find the presence of arsenic in the beers qualitatively, but the accurate determination of the quantity present required a great deal of investigation owing to the arsenic being present in such a large volume of an organic liquid containing so much solid matter. I was anxious to find out if the Marsh test could not be applied as a quantitative one to the examination of beer. Knowing the extreme delicacy of the test I determined to adopt a method of analysis taught me years ago by Dr. Angus Smith, and which he called minimetric—the object being to ascertain the smallest quantity of beer required to produce a mirror of arsenic of a given density.

4269. Would you explain what you found—the quantities of beer with which you worked, and the results so far as the mirrors go?—I will come to that a little later on. I will go on to a description of the apparatus.

4270. Perhaps you will tell us the method you adopt?—Yes. I propose to refer to it as the Marsh test, inasmuch as the chemical reactions involved in the test used by me are the same in principle—that is to say the test depends upon the production of arseniuretted hydrogen gas and the subsequent deposition of the arsenic in the elementary form as a mirror. The form of the apparatus which I have adopted for the examination of beer is exhibited. This is a drawing identical with the size of the apparatus I used (*producing drawing.*) It is necessary to produce hydrogen gas from an outside generator. I use a kip generator which is not shown on the drawing, the hydrogen gas produced is first passed through a tower filled with glass beads moistened with mercuric chloride solution, and then through two towers filled with beads moistened with a solution of silver nitrate in order to get the hydrogen at this point free from impurity (*explaining on the drawing*). Here you have the reducer (*producing model*). You can have three of these connected to the hydrogen supply and worked together side by side, or you may pass the hydrogen through any one of them.

4271. Or all of them, if you have enough?—Yes. The reducer consists of a preparation tube 6 inches long by 1½ inches diameter, fitted with a white india rubber stopper having three holes, one for inserting a stoppered funnel for introducing liquid, a second for exit tube for hydrogen and arseniuretted hydrogen fitted with an upright tube containing a roll of filter paper 3 inches long by half inch diameter. On the tube is bent at right angles a chloride of calcium tube, and at the end of this a piece of combustion tubing drawn out sharply to a fine bore not greater than 2 m.m. outside diameter at a distance of 1 inch from the wide part of the tube. In the third hole is fitted a glass tube for introducing the hydrogen from the outside generator. There are many details of construction about this apparatus which it is essential to follow. In the first place, if you want to make standard mirrows it is essential that you should have your tubes of even bore. Many analysts have failed to detect small quantities, inasmuch as they have attempted to deposit small quantities of arsenic over a large area, in a tube even as large as that (*indicating*).

4272. (*Professor Thorpe.*) You mean as wide as that in bore?—Yes, as wide as that in bore. The consequence is, when you have got very small quantities of arsenic you do not see it; it is lost to sight being spread over too large a surface. Therefore, when you limit yourself to a tube of this diameter you are able to obtain mirrors which would otherwise escape detection. Then, again, one great advantage of having hydrogen from an outside source is this, that you can sweep your apparatus free from oxygen, and after you have swept it away you can allow the reduction to take place in the tube. Then instead of relying, as many analysts have done, upon strengthening the liquid with fresh acid to throw off the arseniuretted hydrogen from the apparatus you have simply to turn on hydrogen from an outside source and sweep it through at a constant flow. Anyone who has attempted to make standard mirrors will know it is a very difficult thing to do—in fact, it is almost impossible—to make standard mirrors without the use of an outside generator. The object I had in view in making my apparatus was to make them definite and make them of a given density, and confined within a limited length of the depositing tube. I can show you a set of mirrors prepared in that way, the object being, of course, to make as clear a line across as possible, quite distinct—not to have the mirrors long. A lengthy mirror is no use to you for comparison. That is the form of metal I used for the reduction (*exhibiting specimen*). It is magnesium. I think that is sufficiently descriptive of the apparatus. But I wish to make the point clear that it is essential these sizes should be followed, that it is essential you should not attempt to carry out the test in a tube of that width (*indicating*). The method of testing is carried out as follows:—The beer to be examined is first boiled to expel the alcohol, cooled, and made up to its original volume. In the reducer is placed a piece of magnesium rod (cleaned by dipping in nitric acid and well washed), 1½in. long × 2th of an inch in diameter, and the apparatus swept clear of air from the outside generator. Of course we have to remember what is the chemistry that goes on within the reducer, and what work is required to be done. It is not the weight of material put in; it is the surface area of metal exposed to the action of acid that brings about the rapid and complete evolution of the arseniuretted hydrogen. If you were to put a piece of magnesium the size of a pea in the reducer, you would get a different set of mirrors. You must ascertain the area required to drive off a given quantity of arseniuretted hydrogen in a definite time. The reduction tube for the mirror is then heated under the full flame of a Bunsen burner, and the hydrogen flame at the jet regulated to 1 millimetre in height. The jet burns at this end of the tube, and it must not exceed 1 millimetre in height. You can conduct an arsenical determination, and you will find no arsenic deposited in the tube, simply because you have perhaps got 3 millimetres or 4 millimetres' height of flame.

Use of hydrog generat from ou source.

4273. The gas is passing away rapidly under too great pressure?—The gas is passing too rapidly. You must allow it to flow slowly; the slower you go the better mirrors you obtain.

4274. (*Professor Thorpe.*) Under those circumstances do you find that the flame 10 millimetres high is arsenic free?—That is arsenic free.

4275. Does a little flame at the end give you no garlic smell?—None whatever.

4276. Have you let the flame impinge upon anything, say nitrate of silver or corrosive sublimate?—I have tried experiments that way. That was one of the points I had to prove—whether the Bunsen burner was sufficient to deposit the whole of the arsenic, so instead of having the tube bent down like that (*indicating*) I carried it forward. I passed it through silver nitrate, and it did not indicate the slightest trace of the escape of arseniuretted hydrogen. You can do it, of course, if you do it too fast; it is all a question of speed.

4277. You have assured yourself that as you do the test no arsenic escapes?—Yes, that is a condition you must fulfil to make the process reliable. I have a series of three reducers, because I work upon one cubic centimetre of beer, 5 cubic centimetres of beer, and 25 cubic centimetres, all at the same time. Into each of the three reducers is run one centimetre, 5 centimetres, and 25 centimetres of the prepared beer respectively. Then 5 centimetres sulphuric acid (containing 50 per cent. H_2SO_4) is introduced into each of the funnels of

the three reducers, and added cautiously and gradually over a period of at least half-an-hour into the reducer. If the amount of arsenic is very small, not exceeding 0·01 miligramme, it is advisable to turn off the hydrogen from the outside generator for the first half hour in order to allow the arseniuretted hydrogen to accumulate in the reducer. If this be done no flame is visible at the point of ignition. After half-an-hour the outside generator is turned on carefully, and for the next half-hour a flame not greater than 2 millimetres is maintained. On the other hand, if the amount of arsenic exceeds 0·01 milligrammes a flame of one millimetre is maintained for the first half hour, and increased to 2 millimetres for the second half hour. That is to throw the arsenic forward in the depositing tube.

4278. (*Professor Thorpe.*) Do you mean to distribute the mirror?—Yes. Otherwise you get grey mirrors which are of little use for comparison. The reason for this is that with traces of arsenic the mirror is so thin and spread out as to be almost invisible if the current of gas is maintained at one millimetre. On the other hand, if the amount of arsenic is large the current has to be maintained in order to get evenly deposited mirrors. I may add that I do not claim anything original for the thing except with regard to the conditions essential for accurate working. It is only a question of manipulative skill.

4279. (*Chairman.*) You make three determinations at the same time, so that you can compare from 5 cubic centimetres and 25?—And 1. I begin with 1.

4280. Are there any special points in the practical application of this method to which you wish to draw our attention other than those you have already mentioned?—No.

4281. You have been good enough to show us a series of standard mirrors?—I have made many various sets of standards from time to time during this investigation. I have two sets which I exhibit. The minimum standard is 0·001 of a milligramme of arsenious oxide, and the maximum standard is 0·01 of a milligramme. I have also prepared a table to assist in calculating the amount of arsenic present. When I take the 1 cubic centimetre, the 5 cubic centimetres, and the 25 cubic centimetres, by comparing it with the 10 mirrors, I can get at once the amount of arsenic, expressed in grains per gallon, from that table. For instance, if you find arsenic in 1 cubic centimetre of beer, it is clear that that beer contains an amount of arsenic not less than 1-14th of a grain per gallon. If you take 25 cubic centimetres of beer there you have a range from 1-36th part of a grain to 1-357th. I have a set of mirrors here to illustrate it. (*Producing mirrors.*) Those are beers using 1 cubic centimetre, and those are beers using 5 cubic centimetres, and those are beers using 25 cubic centimetres, 25 cubic centimetres being the largest amount necessary to take to carry out this test satisfactorily.

4282. (*Professor Thorpe.*) Have you determined whether all the arsenic is eliminated here?—Yes.

4283. Is all the arsenic transformed to arseniuretted hydrogen?—It is.

4284. You have directly proved that, have you?—Yes, it is.

4285. Of course, you know in the case of antimony the whole of the antimony is not?—That is so.

4286. A very considerable portion of it is left?—Yes, but that is not so with arsenic.

4287. You have definitely established that?—I have definitely established that.

4288. It has not been hitherto definitely established?—No, but I did that because I knew that would be one of the points raised against me—How do I know I get the whole of the arsenic out? I believe you can only do it by observing the conditions and working in the manner which I have prescribed.

4289. (*Chairman.*) Does the mirror differ at all in appearance according to the condition in which the arsenic is present—whether it be present as arsenious acid or as arseniate?—I paid special attention to that because if I was only estimating arsenious acid and not arsenic acid, it would not be enough; I must estimate both forms. I found that the appearance and density of the mirror would be the same, but the reduction would be slower, inasmuch as the nascent hydrogen has first to reduce the arsenic to the lower form, and this involves the use of double the energy required when only arsenious acid is present. In other words, it is only a question of time. This answer is based on experiments which I have made. If you start off with ·01 of a milligramme of arsenious acid in the arsenic state, you eventually obtain the same mirror as from 0·01 miligramme of arsenious acid, but you have been expending your hydrogen, that otherwise would have been employed on the production of arseniuretted hydrogen, for reducing the arsenic acid to arsenious acid, but when once reduced it comes off. It is only a question of time. It is a beautiful experiment that can be used as a lecture experiment, showing the speed at which arsenious acid is reduced to arseniuretted hydrogen as compared with an equivalent amount of arsenic acid. It is just like precipitating copper electrolytically. Everybody would prefer to use the lowest oxide of the metal. Cuprous chloride will deposit twice as much copper as cupric salt in a given time. But I have satisfied myself that I estimate both arsenious acid and arsenic acid.

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4290. Do you think there would be any difference in the mirrors if arsenic was introduced in combination with organic matter—as cacodylate, for instance?—I have not yet completed the investigation with regard to the determination of arsenic in organic compounds of such a nature as cacodylic salts. I have, however, prepared mirrors from 0·01 of a milligramme of sodium cacodylate, 0·05 of a milligramme of sodium cacodylate, 0·01 of a milligramme of iron cacodylate, and 0·05 of a milligramme of iron cacodylate. These I exhibit. I have not quite finished the investigation of these organic compounds.

or cacodylate

4291. (*Dr. Whitelegge.*) Do you get the same mirrors with a corresponding amount of arsenic?—Yes, those are the mirrors of the compounds.

4292. (*Professor Thorpe.*) Do the mirrors form quite easily as compared with arsenious acid?—Yes.

4293. In other words, the cacodylate is at once reduced and converted into arseniuretted hydrogen?—Yes.

4294. And with the same facility as if it were so much arsenious oxide?—Exactly. That is my experience. It is rather contradictory to all the evidence that I obtained from other chemists. I was always under the impression these bodies would be very difficult to reduce, and would not yield to the Marsh treatment. A friend gave me the compounds direct from Germany.

4295. Have you assured yourself of the absence of arsenious oxide from the cacodylates. Have you assured yourself that there is no arsenious oxide along with this cacodylate of soda, if it be cacodylate of soda, and this cacodylate of iron?—I have not completed the investigation. I have not made a proper analysis of those things.

4296. You are aware that most cacodylates do contain a quantity of arsenious acid?—No; I do not know that, in the quantities I have taken, it comes from the cacodylates. That is a matter for further investigation.

4297. (*Chairman.*) Have you reason for thinking that when you test beer, which in the course of brewing has become arsenical, you recover the arsenic to the same extent as if it was all present as arsenious acid?—With my present knowledge I am not prepared to answer that question. I think it is sufficient, in the position I take up, to say that I can detect 1-300th part of one grain per gallon in beer. Until the brewers can fulfil a test like that I do not think I can venture into this question.

Application of above test to beer.

4298. Have you examined any contaminated samples of beer which have been brewed with Bostock's glucose or invert?—I have examined highly contaminated samples of beer, but I was not informed by the brewers that they had been brewed with any of Bostock's materials. The highest amount of arsenious acid found was 0·7 of a grain, which was 4d. bitter beer, brewed on the 21st November, 1900, and analysed by me on December 5th.

Quantities determined in beer.

4299. That is not a very large amount?—Well; that is rather a large amount; 0·7 of a grain is 7-10th of a grain.

4300. Yes, but I meant as compared with beers which contained a grain in a gallon?—I should think those are very exceptional.

4301. Have these beers been beers that have been brewed since the epidemic?—No, they were brewed in November, just at the time of the epidemic. I have

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the results of fifteen samples analysed of beers that were brewed on the 5th, 7th, 12th, 13th, 20th, 22nd, 23rd, and 26th of November, December 8th, and December 11th. Those beers varied. Six contained less than 1-100th part of a grain, two contained ·084 of a grain, one ·21, one ·28, one ·35, three ·42, and one ·7 per gallon.

By this test no beer found absolutely free from arsenic.

4302. Have you examined any beer that is absolutely free?—Not absolutely free.

4303. You have not found any beer absolutely free?—Not absolutely free. I have examined since January, 1901, about a dozen samples of beer purchased at public-houses, and found the amount of arsenic varying from 1-70th of a grain down to 1-200th part of a grain.

Glucose practically free.

4304. Have you tested glucose for arsenic by your test?—Yes. I have tested six samples of glucose, and found them all practically free from arsenic. Six different samples were sent in to me by brewers for report. I operated upon 25 grammes of glucose, and the largest amount of arsenic I found is represented in that mirror, which is for all intents and purposes practically free. (*Mirror produced.*)

4305. (*Professor Thorpe.*) That 25 grammes of glucose is absolutely incommensurate with 1 cubic centimetre of beer?—Certainly; you cannot get a glucose in the market that has any arsenic in it now. My difficulty has been to get hold of the contaminated glucose. They will not part with it.

4306. (*Chairman.*) Have you tested sulphuric acid in the same way?—Yes, only I was not so interested in testing sulphuric acid, and I have no quantitative results to put forward. I have a few samples here to show. I do not attach much importance to it, except as showing that some of the purest sulphuric acid in Manchester is highly contaminated, and, on the other hand, the common acid, the commercial acid, is absolutely free from arsenic. That stands good to-day. If you go and buy sulphuric acid in Manchester you will find the commercial acid absolutely free from arsenic, and the purest contains arsenic.

4307. What do you mean by "commercial" acid? Is that the same thing as what we have heard a good deal of—B.O.V.?—Yes.

4308. And that is?—Absolutely free from arsenic.

4309. (*Dr. Whitelegge.*) Do you account for that as owing to it being purified?—I account for it simply because it is acid made from spent oxide.

4310. (*Chairman.*) Not made from pyrites?—Not made from pyrites.

4311. You have never examined an acid that is made from pyrites that has been free from arsenic?—No.

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4312. Not even when it has been purified?—No, and if it has been re-distilled it is not free from arsenic.

4313. (*Dr. Whitelegge.*) I see you take 53 cubic centimetres as your standard quantity of acid?—Yes, those were done some time ago.

4314. (*Professor Thorpe.*) Let us be quite clear about this. Do you mean to say that practically all the commercial acid in Manchester is made from spent oxide?—No, what I mean is this, that if you were to send round to drysalters for a Winchester quart of sulphuric acid, commercial, you would get it absolutely free from arsenic; but if you were to send round for redistilled acid you would find arsenic present.

4315. We ask for an explanation of that, and you say it is because commercial acid is made from spent oxide?—I expect the commercial acid we have in Manchester has been made from oxide. That is the only reason I can give to account for it. I have examined a good many samples of sulphuric acid, made from spent oxide, and they were, as a matter of fact, free from arsenic.

4316. Did you examine any malt by your process? I have examined a few samples of malt and also maize. The samples of maize were free from arsenic; the malt samples were, on the whole, free from arsenic, but one was badly contaminated, and the mirror produced from 25 grammes is shown. I did not make a quantitative analysis. That is the largest amount of arsenic I found in any malt. (*Producing sample.*)

Arsenic n malt.

4316*. (*Dr. Whitelegge.*) How much malt did you take?—25 grammes.

4317. (*Professor Thorpe.*) There again the amount of malt you take is absolutely incommensurate with a cubic centimetre, or even with 25 cubic centimetres of beer?—Yes. I have shown those to other analysts, who say, "We have samples of malt that will give quite a black tube"; but I have failed to have any samples sent to my laboratory. I have asked for them, and they have been promised, but they have never arrived.

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4318. Why, inasmuch as you are dealing with 25 cubic centimetres of beer, do you take an apparatus of those dimensions? Why is it necessary to take a thing which, at least in volume, holds perhaps 150 or 200 cubic centimetres?—There are two reasons for that, the first reason being that these beers are very liable to frothing.

4319. Even when you boil them?—Even after you boil the alcohol off there is still some liability to froth. Therefore a space is provided for the frothing. In the second place, and this is the more important reason, the arseniuretted hydrogen accumulates in the reducer. It acts as a little reservoir, and when you turn on your outside hydrogen you can send over the arseniuretted hydrogen in a condensed form for deposition in the tube.

4320. (*Chairman.*) Have you compared your tests with Reinsch's tests?—Yes. Of course, the Marsh test is far more reliable and delicate than the Reinsch test. I am not at all satisfied with the results of the Reinsch test, and cannot trust it. It has failed in several instances to detect arsenic in beer where the amount was something like 1-20th of a grain, and the erratic results which I have obtained from the Reinsch test made me discard it as a trustworthy test.

Objecti Reinsch

4321. Have you any explanation to suggest why it fails sometimes?—I have tested the method recommended by the Expert Committee of the Brewers' Association. In carrying out the Reinsch test they advise the use of a certain area of copper foil to 200 cubic centimetres of beer. The piece of copper foil they recommend is that size. (*Indicating* $\frac{1}{4}$" × $\frac{1}{2}$".) You take the arsenical beer acidified with hydrochloric acid and place a piece of copper foil that size in the boiling mixture. They recommend boiling for 45 minutes. You boil it for 45 minutes, and you take it out. That piece of copper has not been capable of absorbing the whole of the arsenic in the solution. If you put a second piece in and again heat for a time you would get more arsenic deposited on the copper. If you are going to attempt to make the Reinsch test useful you must take an adequate area of copper foil. I find that 1" × $\frac{1}{2}$" gives much superior results. In working with the Reinsch test where I have failed to get the arsenic deposited on the copper, I have taken the liquid after it has been boiled with the copper and obtained mirrors quite distinct with the Marsh test. (*Mirrors exhibited.*)

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4322. Your modified Marsh test?—The modified Marsh test. That being so, of course, it is not at all a method that will compare favourably with the Marsh test.

4323. (*Dr. Whitelegge.*) Your experience does not confirm what we were told, that the Expert Committee test would distinguish between 1-50th and 1-100th?—No. Most of these beers contain sulphurous acid.

4323.* What is the action when you put copper into that?—It turns black almost immediately, and the arsenic will not deposit on it. I have tried my best to make a success of the Reinsch test, but I cannot make it. It has failed in many important instances in the examination of beer, and never once has the Marsh test failed.

4324. (*Professor Thorpe.*) If that beer is boiled with hydrochloric acid, what becomes of the sulphurous acid which is in the preservative?—Of course, it will be evolved.

4325. Therefore it does not prevent the deposition of the arsenic?—Well, all the sulphurous acid is not evolved when you put the piece of copper in after bringing the liquid to the boiling point, and it immediately goes black. If you take a little bi-sulphite and do that your copper will go black at once.

4326. You are not aware that as the Expert Committee's test is worked it is quite possible to get results even with the presence of sulphurous acid?—It is possible to get results, but you get erratic results; sometimes you fail to get it.

4327. Have you any experience of Gutzeit's test?—Yes, I consider it a superior test to that of Reinsch's, but I do not care for it as a quantitative test, as the resulting stains fade very soon, and cannot be retained for exhibition in Court cases.

4328. Have you ever met with red mirrors, which suggested the presence of selenium, in the course of your Marsh tests?—No, I have never met with any

No sele mirrors with in tests.

mirrors that would suggest selenium. Selenium deposits from seleniuretted hydrogen at very low temperature (150 deg. up to 270 deg.). At a red heat it passes on undecomposed and can be detected at the point of ignition on a cold porcelain basin. Arsenic is only deposited from arseniuretted hydrogen at a higher temperature (red heat). If selenious acid is introduced into a Marsh reducer the selenium is deposited as a red powder, and I have failed to detect selenium with the Marsh apparatus unless when the selenium is added as a selenide and when no reducing agent as magnesium is present. Those are selenium mirrors produced from seleniuretted hydrogen. (*Producing mirrors.*) It has been suggested that sulphur might interfere with Marsh mirrors. Here is a set of mirrors produced from sulphur alone, showing they are quite distinct, and cannot be confounded with the arsenic mirrors, nor do I find that selenium in the generator interferes with the evolution of arseniuretted hydrogen. I have taken definite amounts of arsenious acid and recovered the arsenic mirrors equivalent to the mirrors that are used as standards. You could not get selenium and arsenic to lie together in a mirror.

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4329. (*Professor Thorpe.*) No, but they lie one in front of the other. Have you not noticed that?—I have not noticed that. In my case the seleniuretted hydrogen came out, and I found it at the point of ignition, and could get it deposited on a porcelain basin.

4330. But you do not find it near the red-hot flame with which you heat the tube, with the arsenic after it, do you. You do not find it like that?—No.

NINTH DAY.

At the Town Hall, Manchester.

Friday, 29th March, 1901.

PRESENT:

The Right Hon. Lord Kelvin (in the Chair).

Sir William Church. | Dr. Whitelegge.

Mr. Cosmo Bonsor.

Dr. Buchanan, *Secretary.*

Dr. Judson S. Bury, called; and Examined.

Dr. J. S. Bury. 29 Mar. 1901.

4331. (*Chairman.*) You are physician to the Manchester Royal Infirmary?—Yes.

4332. And have you made a special study of neuritis?—Yes.

4333. And have you written on the subject?—Yes.

4334. Papers in medical journals?—Dr. Ross, many years ago, began a series of articles on peripheral neuritis that were published in the Manchester Medical Chronicle. After his death his friends and his widow asked me to complete them, and I completed them, and they were published in book form—a separate book called "A Treatise on Peripheral Neuritis," published by Griffin and Company.

4335. You are the author?—Joint author with the late Dr. Ross. The book was published in our two names; I wrote the latter half.

4336. You have been familiar with alcoholic neuritis?—Yes. I also wrote the article on "Peripheral Neuritis" in Professor Clifford Allbutt's "System of Medicine."

4337. You have been familiar with alcoholic neuritis in Manchester?—Yes, for many years—for 15 years.

4338. Do you distinguish between alcoholic neuritis as a particular variety of peripheral neuritis?—Yes.

4339. Does alcoholic neuritis essentially belong to peripheral neuritis?—Yes. We regarded it as one of the varieties of peripheral neuritis, alcohol being one of the chief causes of the condition known as peripheral neuritis.

4340. Have you seen cases during the recent epidemic?—Yes, I have seen a good number.

4341. And do you consider that they differ in clinical aspect from alcoholic neuritis?—Yes, I do. Are you referring to the aspect of the cases generally, including the skin lesions.

4342. Yes, the cases that have occurred during the recent epidemic, the remarkable cases?—Yes; they differ, so far as I can remember, from the old cases that we saw before last year. They were what we called alcoholic neuritis.

4343. Did the cases during the recent epidemic differ conspicuously from what you formerly knew as alcoholic neuritis?—A great many of them did, not all.

4344. Do you think that some of the old cases of alcoholic neuritis may possibly have been due to arsenical poisoning?—I think it is possible, but I do not think that a scientific assertion one way or the other could be made at present. One may have one's leanings towards one view, but I do not think that the evidence is sufficient to make a definite statement.

Undue prevalence of alcoholic neuritis in Manchester before epidemic.

4345. Has there been any neuritis, peripheral or alcoholic, or other special neuritis noticed in Manchester different from what might be found or has been recorded in other towns?—The alcoholic variety has been, so far as I know, very prevalent in Manchester and the neighbourhood, as compared with other towns.

4346. More prevalent in Manchester, for instance, than Edinburgh or Glasgow?—I believe so.

4347. Have you noticed a statement by Sir William Gairdner, the late Professor of the University of Glasgow, regarding cases of neuritis in Manchester of about 15 years ago?—Yes. I heard the letter read.

4348. Were you present in London?—Yes. I was present at the discussion at the Royal Medico-Chirurgical Society.

4349. But not at the meeting of this Commission?—No. The same letter was quoted at the Society.

4350. Does that letter strike you as proving there was this arsenical neuritis, that these cases may have been of the same character as those which have become so prominent during the recent epidemic?—Do I understand you to mean: is that a proof that the cases in Manchester were more likely to be arsenical?

4351. It would have a bearing on that. In respect of symptoms, do you consider that these cases presented symptoms analogous to the recent cases—that these cases noticed by Sir William Gairdner presented close analogies with some of the recent cases that have attracted so much attention?—I do not know that Sir William Gairdner in his letter did refer to that. He rather referred to the absence of cases in Glasgow, I think.

4352. (*Dr. Whitelegge.*) He referred to cases he saw in Manchester?—Yes.

4353. (*Chairman.*) I meant the cases in Manchester to which he refers. Dr. Ross was your colleague?—Yes: he showed some cases to Sir William in Manchester

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4354. It appeared to Sir William Gairdner that those cases with which he was struck in Manchester, and of which he did not know analogues in Scotland, may have been of the same character as some of those which have attracted so much attention in the recent epidemic?—That is not a very easy question to answer. Of course, in answering it one has to speak on the whole question as to the past existence of real alcoholic neuritis, and that would lead one to speak of differences that occur to one between the old cases and those of the present epidemic.

4355. Have you noticed the diagram in Dr. Tattersall's report? On the extreme left of the diagram there is a red line, a 20th part of the height of that which occurs in 1900. That seems to indicate that the cases so marked and numerous in 1900 were of the same character as cases that appeared in much smaller numbers for many years before?—Of the same character, I assume, as regards the existence of multiple neuritis; that is, that they were all cases of multiple neuritis—multiple peripheral neuritis. That is another name for it.

4356. Is multiple neuritis a kind of peripheral neuritis, or does multiple neuritis mean the same thing as peripheral neuritis?—The name "multiple" is added to express the idea that a great number of the peripheral nerves are affected. Peripheral neuritis might be applied to disease of a single nerve. The term "multiple" is added to make the title more explicit. Dr. Tattersall's diagram simply refers to the number of cases at different periods of multiple peripheral neuritis, but does not refer to the cause at all.

4357. Was there any suspicion that the special cases, of which five or six were brought before Sir William Gairdner, in Manchester, had anything to do with arsenic?—There was no suspicion then.

4358. And there was no suspicion that the cases indicated on the left-hand side of Dr. Tattersall's diagram—that is to say, between the year 1890 and 1893—had anything to do with arsenic?—No, no suspicion whatever, so far as I know. In fact, up to last year all the cases in which alcoholic beverages had been taken to a considerable extent were put down as alcoholic neuritis. Of course, there are many other causes of peripheral neuritis.

may have been partly due to arsenic.

4359. In the light of recent events we attribute a large proportion of what is represented by this red line for the year 1900; we now know from evidence that it is a thoroughly well founded opinion that a large proportion of these cases are due to arsenic?—Some, no doubt; possibly a large proportion, but not necessarily all.

4360. That is to say, some of these cases might be alcoholic neuritis independently of arsenic?—In my opinion, yes.

4361. Or neuritis from some other causes than alcohol?—Possibly.

4362. Some other cause different from either alcohol or arsenic?—Possibly, but more likely to be alcohol without any arsenic.

4363. Judging from the light given since the end of the year 1900, do you think it probable that some of those older cases of peripheral neuritis were probably due to arsenic?—No, I do not consider it probable; I consider it possible.

4364. You do not think that the recent experience makes it probable that some proportion of those were due to arsenic?—I do not think so; I do not think it is probable.

4365. Have you any conjecture or explanation to give us?—In the first place, the late Dr. Ross, who was working very diligently at the subject between 1887 and 1890, when I was working with him, took very great care to record all the symptoms presented by the patients in the infirmary who had peripheral neuritis, and I find it difficult to conceive that any marked skin lesions would have escaped our observation.

Skin lesions.

4366. The skin lesions you take as one of the symptoms essential to the probability of arsenic?—Yes, essential to the probability. I do not say that arsenical neuritis might not exist without skin lesions, but at any rate that would be one of the main things on which our diagnosis would be based.

4367. Can you suggest any reason for the great prevalence of one form of peripheral neuritis 15 years ago in Manchester as noticed by Sir William Gairdner—the fact of that being so comparatively frequent in Manchester and non-existent, so far as known, in Scotland? Can it be due to the national alcoholic beverage in Scotland, whisky, and the alcoholic beverage in this part of England, which I suppose may be called beer?—That I cannot answer, except that they take enormous quantities of beer in this district.

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4368. And enormous quantities of whisky sometimes in places in Scotland?—Probably they would not be able to continue work so well if they took a proportionate amount of whisky here. Beer is the more diluted form of alcohol. Still, I could not answer that question.

4369. I wish to find out whether you consider that the facts make it probable that there may have been occasionally arsenic in beer in Manchester as an exciting cause of these illnesses, and that the fact of these illnesses being comparatively frequent in Manchester and infrequent, or non-existent, in Scotland may be due to the comparative rarity of beer-drinking in Scotland and the reverse in the middle of England?—I consider it probable that arsenic might occasionally have been the cause.

4370. The difference being beer with arsenic in Manchester and not in Glasgow or Edinburgh; but you could not say you think it probable from your own experience and knowledge?—No, I should not care to give a definite answer to that, because it is rather outside the scope of evidence that one has had before one. It is only a speculation.

4371. At most any such opinion would be merely conjectural?—I think so.

4372. Can you give us particulars of some of the cases that you have seen?—I went over the cases of peripheral neuritis that I had in my own wards last year. The numbers are: One in January; then no case until July; two in July, four in August, one in September, five in November, and eight in December. Those numbers refer to the admissions of patients to my wards at the Infirmary.

Clinical differences between arsenical a alcoholic neuritis n always apparent.

4373. Do you distinguish those cases from cases which you previously had?—Some of them, undoubtedly.

4374. Of the whole number you have mentioned some of them are not absolutely distinct from what you had known before?—Probably not.

4375. Do you think that alcohol itself was the essential cause of the alcoholic neuritis cases with which you were familiar before the epidemic?—I think that the evidence points in that direction.

4376. Can you give instances of so-called alcoholic neuritis in persons drinking spirits and no beer?—Yes, I have seen it in sailors who have taken rum chiefly. Of course, it is difficult to exclude other beverages; one cannot always get authentic information. But at any rate in sailors who have alleged they have taken principally rum, I have seen it, and in ladies who have taken brandy only, and I have seen it in whisky drinkers too.

Alcoholic neuritis in spirit drinkers.

4377. Do you attribute the illness to the effects of alcohol in these cases?—I have done, and I am still inclined to do so. There may be arsenic in some of the spirits that have been taken, but I should be inclined at present to attribute the neuritis to the alcohol. There are a few collateral lines of evidence in that respect. The late Dr. Ross in his collection of cases—77 cases he had collected from the literature of alcoholic neuritis—found that in 22 of these large quantities of spirit, and spirit only, were given in the histories of the patients.

4378. One-third of the whole number?—Yes. Then some individuals after taking a very small quantity of spirits or wine will suffer from a very slight form of peripheral neuritis—from numbness and tingling—a day or two afterwards, or the next day. That is slight evidence to suggest that alcohol affects the peripheral nerves or tends to affect them.

4379. Were these disturbances you mention due to excessive use of alcohol for a day or two, or only to a small quantity?—I mean a single glass.

4380. A single glass of whisky or spirits has produced the effects you now describe?—Of course, it is only fair to say that some of the patients I have referred to were gouty individuals, so that it is very difficult to eliminate a gouty tendency.

4381. Persons not drinking from day to day have had the experience?—The late Dr. Ross was very fond of quoting one case in which a patient of his, after a single glass of wine, would have not only numbness and tingling at the extremities, but his nails would begin to crack.

4382. Time after time on the same individual?—I believe so, so far as I remember. I know he quoted that case in the wards very often.

4383. (*Sir William Church.*) Lord Kelvin directed your attention to this diagram, and pressed you about it. When was the term "alcoholic neuritis" used commonly in Manchester in your registers?—Ever since I became connected with the infirmary in 1885. I became medical registrar to the infirmary in that year, and the term was used then, or at any rate a year afterwards.

4384. Do you remember when it was first introduced into the nomenclature of disease. As a matter of fact it was at that date. It was not in the nomenclature before 1885?—No; but papers were written with that title.

4385. Yes, but it did not go on the register?—I did not know that.

4386. That being the case it is quite possible that cases would have been only put down as alcoholism without the form being mentioned?—Yes.

4387. So that some of this gradual increase may be due rather to the use of the term than to an increase in the disease?—Quite so. I am not sure whether you have had the figures from the infirmary of cases during the last 10 years?

4388. Yes, we have. Lord Kelvin pressed you also rather about the condition of the population who exceed in alcohol in other parts of the kingdom, but is it not the fact that there are other effects of alcohol besides peripheral neuritis?—Yes.

4389. Is it not the case that these effects are found to differ a good deal in different parts of the kingdom? For instance, what I have in my mind is cirrhosis of the liver, gin drinkers' liver, which is said to be almost unknown in Scotland, or very rare?—I do not know.

4390. It is not met with in the post-mortem room of Edinburgh or Glasgow?—I think I have heard it said so.

4391. Gin drinkers' liver is usually attributable to alcohol, is it not?—Yes.

4392. Therefore, it is possible, though we do not know much about it, that the effects of alcohol in different beverages may be slightly different on the system?—Quite so.

4393. Did the milder cases of what are supposed to be arsenical neuritis that you have seen during the past year differ in any respects from what you would have considered alcoholic neuritis formerly, where there was no pigmentation or rashes?—I think that type cases of arsenical neuritis differ from alcoholic neuritis.

4394. I wish to leave out the typical cases?—I mean leaving out the skin lesions, and simply referring to the paralytic symptoms. To begin with, the sensory symptoms, I think the cutaneous hyperesthæsia is certainly more severe and more persistent than in cases occurring before this epidemic.

4395. That is what I had present in my mind. I have seen some of these cases; to me the hyperesthæsia was very much greater than anything I have seen before?—Before coming here I referred to Dr. Ross's account again, and he makes a special note of that fact in giving the clinical symptoms of alcoholic neuritis; he says that cutaneous hyperesthæsia although present is always subordinate to muscular hyperesthæsia in the alcoholic cases. That is in accordance with my own memory of the old cases. In the cases that I have studied carefully in my wards the cutaneous hyperesthæsia has been something remarkable, and in one or two cases one of the most remarkable things I know in clinical medicine. To give you an example. A man came into my wards in February of this year. He had been under hospital treatment since last May in Halifax. He had been a fairly heavy drinker. He has been in hospital practically ever since, and he certainly had not had access to any alcoholic beverage. When he was under my care, between February and March, there was very little motor paralysis. He stated that when he was in Halifax he had complete motor paralysis. He recovered from that, and the only remaining symptom was the excessive hyperesthæsia. Stroking the sole of the foot gave him agonising pain, and the sole of the foot was also red. There was not a shadow of suspicion that there was anything of a hysterical nature about him. The nails were intensely tender, so that the slightest pinch would cause him the greatest pain. It reminded me very much of touching the exposed nerve of a tooth from the suddenness of the shock of pain. For a fortnight, while he was in the infirmary, these symptoms seemed to get worse. We sent him out to the Cheadle Convalescent Hospital in much the same state. Here then is a man who has been at rest in bed since last May, in whom there appears to be no improvement whatever in the severity of the cutaneous hyperesthæsia. It seems as if the ends of the nerves were exposed or bulbous, or in some unusual condition.

4396. (*Chairman.*) Is he still in hospital?—Yes, at the convalescent hospital at Cheadle. I certainly do not remember anything approaching that in the old cases. To a modified degree it is also one of the notable features of other cases.

4397. (*Sir William Church.*) Both the sensitiveness of the skin and also the pain upon making pressure upon the muscular tissues is very much greater than in the older cases?—Yes; I do not feel so confident about the muscular hyperesthæsia, but I think we should have remembered the cutaneous. I have never seen anything like this before.

4398. (*Chairman.*) Is this probably due to arsenic?—I think so, because the man had some scaliness of the hands and feet when he came in, and the redness has persisted. With regard to the distinctions, that is one marked thing, the cutaneous hyperesthæsia. With regard to the motor symptoms, I think that they also are different. There is a far greater tendency to active spasm of muscles, much greater than I ever remember seeing in the old cases. In fact, so struck was I with one case in the past of active spasm of muscles that I remember especially drawing attention to it in the book. It was a case in which the hands somewhat resembled the aspect of tetany, but in most of the alcoholic cases, so far as I remember, the condition of the hands was a loose one. The wrist was dropped, and the fingers were more or less loose, so that you could test them in various ways. In the majority of the present cases the condition of active spasm is a very noticeable feature. The typical arsenic hand is a distinctly curled one, with marked contracture.

4399. Is that an old, known symptom of arsenical poisoning?—Yes, the contractions are, rather laid stress on in some of the accounts. I think Raymond, a French writer, lays stress on them. Then the extensors of the fingers are certainly more affected than in the alcoholic cases. Some of the cases which are distinctly arsenical, as proved by the skin lesions, I have tested over and over again. They can move their wrists a little, but the paralysis of the extensors of the fingers is complete. I am inclined to think that is a difference, and I find that Professor Raymond also mentions it in his account. Then the contractures are more marked. I have a man now in whom supination is impossible, owing to marked contracture of the pronator radii teres.

4400. (*Sir William Church.*) Contraction of the lower limbs, too, is not infrequent?—I do not like to speak too positively, because it is difficult to remember old cases, but I certainly think active spasm is a more marked feature in the present cases and contractures too are more common. Coming to the associated symptoms, especially to the mental condition, I think there is a very marked difference. In the present cases, although you meet with mental disturbance, it is nothing like the degree of that met with in the real alcoholic cases, where failure of memory for time and place, and chronic delirium are conspicuous features.

Mental disturbances less in arsenical cases.

4401. Many of these cases would be probably mixed; they would be suffering both from alcohol and arsenic, so that that would account for a good many having the mental symptoms very similar to what we have associated with alcoholic neuritis before?—I quite agree. In my opinion three varieties may be distinguished—pure alcoholic cases, mixed cases, and pure arsenic cases. I was very much interested in talking to the sister of my ward—a woman of very great experience and a very acute observer—and she spontaneously referred to the difference as regards the mental type in these cases.

4402. Did you notice any other symptoms in these cases which you associated with arsenicated beer which differed at all from what you had previously been accustomed to associate with alcoholic neuritis in the condition of the other viscera?—In one of my cases the bladder and rectum were markedly affected, which I believe is almost unknown in alcoholic cases. With regard to the heart, I should be inclined to think that we had more cases of dilatation of the heart in the past, but I think that is a much more doubtful subject. Furthermore, there is a greater tendency to point affections in the arsenical cases.

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4403. I was thinking more especially of the liver?—Our experience of what we call the alcoholic liver has been that it is a large liver, fatty, with some interstitial tissue, and that the small hard liver is rare in Manchester.

4404. With regard to the cases of the last year, have the large proportion of them had enlarged livers, or a smaller proportion?—A smaller proportion I should be inclined to say. There are just one or two other details with regard to the symptoms. I think the atrophy is more marked, and there is more tendency to a general wasting in the arsenic cases. They are often thinner and more wasted, and the atrophy is more widespread.

Atrophy of muscles.

4405. Still, a good many of these cases did not seem to have lost fatty tissue; the paralysed muscles are wasted?—More generalised muscular atrophy. I think muscular atrophy was more localised in the old cases.

4406. Have you any suspicion of any other disease? It has been suggested, for instance, that some of these may be the results of influenza?—I do not think so for a moment.

Admission to Manchester R. Infirmary of neuritis patients.

4407. You appear, during the last year, to have had 21 cases under your own care in the infirmary?—Yes, there were 62 cases in the wards, and I had 21 of them.

4408. What would be the total number of admissions to your wards during that time?—I could not tell you that.

4409. Perhaps I can get at it in a different way. Could you tell me what would be your average number of admissions from alcoholic neuritis in former years?—The total number varied from 20 to 37 in the hospital. I should probably have about a third of them.

4410. Seven or eight a year?—There are four physicians, and the two assistant physicians have three or four beds each. I usually get about a third of the nervous cases, as far as I remember, so that that would be an average of eight to ten roughly. I should not think more.

4411. Accepting the suggestion that they had drunk more beer in Manchester and Liverpool than they had in the South, you have no other explanation to offer for what appears to be very remarkable; that is, the much greater frequency of alcoholic neuritis here than in London, for instance?—No.

4412. What proportion do you think your in-patients with this affection bore to the out-patients? I suppose a large number of milder cases of peripheral neuritis or alcoholic neuritis would be treated as out-patients?—Yes. I do not know what the proportion is.

4413. You could not tell us what increase there has been in the milder cases during the past year?—No. I have had nothing to do with the out-patients for the last two years. Before that I was in the out-patient department as assistant physician for some years. They did not occur every week, even in the out-patients' room.

4414. (*Dr. Whitelegge.*) Have you seen many cases outside the infirmary?—I have seen several cases.

Pigmentation in neuritis cases in 1900 and before.

4415. In the cases which were observed and recorded by Dr. Ross and yourself, I understand there was no instance of pigmentation?—There is none recorded in Dr. Ross's account, and I do not remember any. I certainly have no recollection whatever of pigmentation.

4416. Before 1900?—No.

4417. In the cases you have observed in 1900, pigmentation is frequent, is it not?—It is not so frequent as the scaliness of the hands and feet, and often has to be very carefully looked for. The first case I had in November was one of the most marked cases in the epidemic, the man's skin was a deep bronze tint. I have examined the skins very carefully since then. Many of them are slightly pigmented, but in others pigmentation is not easy to find. The keratosis of the hands and feet was the most important skin lesion.

4418. The pigmentation you would regard as a point of distinction, although not always occurring, between the two types?—Yes.

Keratosis.

4419. Was keratosis observed in the old alcoholic cases?—It is not mentioned in Dr. Ross's cases, and I have no recollection of it. I also asked the sister I have referred to, and she does not remember it at all.

4420. Before the recent epidemic, was arsenic familiar as a cause of neuritis?—Yes.

Toxic effect of arsenic increased by alcohol.

4421. Do you hesitate to give arsenic to alcoholic patients? Do you regard alcoholism as predisposing to arsenical mischief?—I think it is very likely. The two drugs appear to pick out similar parts. I think it is very likely that a stimulant like alcohol would help arsenic, or that they would be of mutual assistance.

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4422. Are those cases which you regard as distinctly arsenical more prevalent in women than in men?—I could not say, because I have only had a limited number of cases under my own observation, and I have not gone into the statistics. With regard to the old cases, the bad cases were certainly more common in women in hospital practice.

Severity of disea greater women.

4423. (*Chairman.*) Before the recent epidemic?—Yes. But the milder and moderate cases I should think were just as common in men.

4424. (*Dr. Whitelegge.*) You are referring to the alcoholic cases?—Yes, the old cases.

4425. Do you assign any reason for that?—The occupation of a man tends to prevent continuous drinking; a woman left at home can give up the whole day to it if she likes. Then, of course, the effect of being out of doors will tend to the quicker elimination of alcohol.

4426. And you attribute the difference to these causes not to any constitutional predisposition?—I think the causes I have mentioned are more likely.

4427. Do you attribute a considerable part of the recent epidemic to arsenic?—Yes.

4428. But not the whole of it?—No. Nor do I think it is at present easy to speak positively with regard to many of the paralytic symptoms, as to how far they are due to alcohol or to arsenic. I wish to speak in a perfectly unbiassed way about it, simply referring to the evidence we have.

4429. (*Chairman.*) Was there any special reason for the increase of non-arsenical alcoholic cases in 1901?—I should not like to say they have been increased.

4430. So that the extra number in the recent epidemic is probably due to arsenic?—Yes; although, of course, it may be that alcohol has helped.

4431. Arsenic with alcohol may have caused the increase?—Possibly.

Toxic e of smal quantit of arse in beer.

4432. (*Dr. Whitelegge.*) You have followed what has been said about the quantity of arsenic in beer?—Yes.

4433. Does it appear to you that the amount of arsenic that has been found in beer would be sufficient in ordinary circumstances to give rise to the symptoms now attributed to arsenical poisoning?—Certainly, in a large number of cases, because there has been really a large quantity of arsenic.

4434. The dose was adequate?—Yes. In a large number of cases, where the dose has been small, it is difficult to say. Take a dose of, say, 1-20th of a grain in a gallon; that is equivalent to 5 minims of liquor arsenicalis in 8 pints. A dose of that sort I should regard as a kind of borderland dose. It would be very difficult to say whether 2½mms. of liquor arsenicalis twice a day taken for many months would produce symptoms.

4435. You might also suspect in these cases a larger dose than the chemist had found?—Yes, I think it is very likely. Of course, the question with regard to the past depends on the possibility of small doses of arsenic having produced some of the symptoms, and that I find very difficult to answer.

4436. (*Chairman.*) We have had cases given in evidence in which the beer consumed was alleged to be from a pint to two pints—not more than two pints. Do you think that 1-50th of a grain in such circumstances could be detrimental?—I should not think it is at all likely.

4437. Taken day after day, week after week?—It would be rather against our experience of medicinal doses, that is, only half a minim of liquor arsenicalis. We usually begin with about 3 minims. Thus 1-50th of a grain would be one-sixth of an ordinary minimal dose.

4438. Two pints per day under those circumstances would be a very small dose?—I think so. It is only fair to say that one might be sceptical about the "one or two" pints as well as about the quantity of arsenic.

Quanti beer co sumed persons attacke

4439. It is also possible that in those cases, if the patient was truthful, it might have been some of the worst specimens of beer?—Certainly. I think it is quite possible there may have been much more arsenic in some of the beers than has been imagined; but I have taken great pains in the cases I have had, where

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there has been a doubt as to the quantity of beer taken, to make careful enquiries, and I have never satisfied myself in a single case that a small quantity of beer has been taken. In one case, in which a small quantity was alleged, I had the friends down to my consulting room and asked them, and they said it was quite correct, that the man had never taken more than one or two pints at most. Then I found he had held an important position in a bank some years ago, and I could not get an adequate reason for his leaving. I asked his wife, "I suppose he did not get intoxicated?" and she said, "Oh, yes, he got intoxicated." I said, "How often? Once a week?" and she said, "Sometimes oftener than that." So it is very difficult indeed to get accurate accounts with regard to the amount taken.

4440. In many cases the patient's allegation of extreme moderation is not true?—Hardly ever.

4441. Have you looked at all into the quantitative analyses that different chemists have given?—I have read them over.

4442. Have you any remarks to make upon them. There are great discrepancies among different chemists?—Yes.

4443. (*Dr. Whitelegge.*) Have you noticed considerable differences in the susceptibility to arsenic? Is it a fact that that susceptibility to arsenic varies greatly?—I should think so.

4444. Could you say what is the smallest amount you found to produce a toxic effect?—No. I could not recollect. I am thinking of the treatment of chorea cases. Toxic effects from arsenic in chorea are not very common.

4445. (*Chairman.*) You might meet with exceptional cases?—Yes.

4446. But you cannot give us any particular information about that?—No, except that comparatively small doses in chorea cases sometimes produce pigmentation.

4447. What kind of dose are you thinking of now?—I could not at the moment give accurate figures.

Mr. Carter Bell, called; and Examined.

C. Bell.

4448. (*Chairman.*) You are an Associate of the Royal School of Mines?—I am.

4449. And you have had many years' practice as an analyst?—About forty.

4450. You are also analyst for the County of Chester and for several boroughs?—Yes, Salford, Birkenhead, Stalybridge, Congleton, and Glossop.

4451. During the quarter ending December 31st, 1900, you analysed many samples of beer?—Yes, I have analysed for the County of Chester in that time 82 beers and 30 of those contained arsenic. For Salford I analysed 58 beers and 7 of those contained arsenic. For Stalybridge I analysed 7 beers, and 4 contained arsenic; for Birkenhead I analysed 29 samples and 11 contained arsenic; for Glossop 21 beers and 8 contained arsenic; for Congleton no samples were sent in at all. I may say that the Corporation of Warrington—I am not their analyst—sent to me, and I analysed a considerable number for them, and some of their beers did contain traces of arsenic.

4452. Eighty-two samples from the county of Chester, and 30 of them contained arsenic. What quantity of arsenic?—The quantity was not estimated in every case, but I estimate that it varied from 1-10th to 1-50th or 1-100th of a grain per gallon, but I may say that those were not estimated very accurately simply for the reason that so many samples came in that I had to do them very quickly, and I used to write off to the inspectors and tell them to stop the sale of that beer at once. As we went on the authorities wrote to me to say that no prosecutions were taking place, and therefore there was no necessity, when they had stopped the sale of the beer, for further investigations of those samples.

4453. (*Dr. Whitelegge.*) Did you take steps to stop the sale of the beer irrespective of the amount of arsenic you found?—Not in the 1-100th of a grain I should not, but where I found 1-10th, or, as I considered, over a tenth of a grain, I wrote to the inspectors at once, and told them that they must stop the beer at once.

4454. (*Mr. Cosmo Bonsor.*) Is that the inspector under the Sale of Food and Drugs Act?—Yes.

4455. (*Chairman.*) Were some of the arsenical samples of beer those in which Bostock sugar had been used?—They were.

4456. Did you find more than 1-10th of a grain of arsenic in some of these?—Yes, I should say there was more than 1-10th.

4457. During this quarter you have examined 128 samples from the County of Chester, of which 19 contained arsenic?—That is this present quarter. I have analysed already this quarter, the quarter which will end on the 31st March, 128 samples, and 19 have contained arsenic. Now the authorities in Cheshire have determined that in cases where arsenic is found prosecution shall take place, and we have just had one at Nantwich against a brewery and a publican, where I have certified that the beer contained 1-10th grain of arsenic to the gallon. The prosecution took place about a fortnight ago and a conviction followed.

4458. (*Dr. Whitelegge.*) Can you say against whom the prosecution was taken?—Against the publican and the brewer. *Mr. C. Bell.*

4459. How did the brewer come into the case?—He supplied the beer; it was a tied house.

4460. Were you present at the hearing?—Yes.

4461. Was it on warranty that he was brought into the case?—No, he was summoned. There were two summonses issued, one against the publican and one against the brewer.

4462. (*Mr. Cosmo Bonsor.*) Is there a report of the case?—Yes, in the newspaper.

4463. Could we have it put in?—It was a fortnight ago last Monday.

4464. (*Chairman.*) What was the finding?—The publican was fined, I think, £2 and costs, and the brewer £30 including costs.

4465. Did it appear in the trial on what date the brewing of the beer was made?—Yes, it did. I believe the beer was supplied last quarter, and notice had been given to the publican not to sell this beer.

4466. Notwithstanding that notice he sold it?—I believe so. The excuse that the brewery people made was that they left the beer in the cellar intending the railway company to bring it back to their brewery so that they could destroy the beer, but they had so many barrels to take away at that time that it was forgotten.

4467. And the publican sold it?—It was sold to the county authorities.

4468-71. Your inspector went as a customer and bought that beer?—Our inspector sent his boy into this place, a boy about thirteen, to buy a quart of beer. The son bought the beer and paid for it; his father was in the street and the son beckoned to the father to come in, and the father said, "This beer has been bought for me for analysis, and I shall divide it out into three parts and send one part to the county analyst." That was done. I certified the beer contained 1-10th grain of arsenic to the gallon.

4472. Was it proved in the case that the publican took this from one of the condemned barrels?—Yes, it was.

4473. (*Sir William Church.*) On what grounds were the brewers fined the £30?—Because it was a tied house.

4474. And the publican was supposed to be acting as their servant?—Yes.

4475. Although he disobeyed their orders?—That is so.

4476. (*Chairman.*) The £2 was the punishment for selling beer which was known to be condemned as containing arsenic?—Yes.

4477. (*Sir William Church.*) I do not know whether you have the same information that we have with regard to the brewers' names, but I should like to have the name of the brewer. I will give you the list of those that we have already had evidence about. (*List handed to Witness:*) Is the name of that brewer there?—No.

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4478. The name will have appeared in the papers?—Yes; it was the North Cheshire Brewery.

4479. (*Chairman.*) We should have the reported evidence of that trial; can you send in to Dr. Buchanan the evidence?—Yes.

4480. There was no trial in the county of Chester for sales of beer during the quarter ending with 1900?—No, none.

4481. The trial you have just referred to was for sales during the first quarter of the present year?—Yes.

4482. There was a second prosecution not yet heard, I believe?—Exactly, but it is to be heard on April 17th.

4483. Your case there was the analysis of a sample purchased by the inspector?—Yes.

4484. It was supplied by the inspector to you?—Yes.

4485. What amount of beer did you take?—About 20 ounces was sent to me; about a pint.

4486. How much arsenic had you found in this case?—That I have certified as 1-30th of a grain of arsenic to the gallon.

4487. That you certified in court?—I have given it on my certificate.

No arsenic found in jams sweets, &c.

4488. From the county of Chester you have also received specimens of sweets and jams?—Yes, large numbers.

4489. In any case have you found arsenic?—Not in any case.

4490. Did you use quantities such as would have shown the arsenic by the same test as that by which you found it in beer?—Exactly the same, and I found no trace at all.

4491. You also examined cheap pickles and vinegars?—Yes: but no arsenic was there.

4492. In the figures for Salford there are 58 samples of beer of which seven contained arsenic?—Yes.

4493. Up to the present date how many samples have you analysed?—Twenty up to the present date, and none of them contained arsenic.

4494. Dr. Tattersall has told us that he sent to you samples of Groves and Whitnall's beer to examine them for mineral poison?—Yes.

4495. Was that before the discovery of arsenic by Dr. Reynolds?—Yes.

Arsenic not detected in earliest samples of arsenical beer from Salford.

4496. Did you examine those samples for mineral poison?—I did. But I may say that in reference to those samples a letter was sent to me to examine them for the higher alcohols, such as amyl alcohol. In the first samples there were six ounces, and in the next eight there were a few more ounces; by the time I had used up these 14 samples for the examination of the higher alcohols a special message came up from the Town Hall, at about 11 in the morning, asking me to examine these for arsenic. I had hardly anything left, and I was desired to get it done by 2 o'clock. It was not easy to examine 14 samples in about two hours. I immediately put what little I had in the Marsh apparatus, but it gave no indication of arsenic whatever. I went down to the Town Hall, and said I had not found any.

4497. What quantities did you have in that necessarily hurried examination?—In the first instance I had only the first six samples; there were six ounces of beer, and I was asked to analyse that for the higher alcohols. That took nearly the whole of that quantity, and I do not think I had an ounce or half an ounce left. I thought if any appreciable amount of arsenic was present one must find it by the ordinary Marsh test.

4498. Even in an ounce or half an ounce?—If there had been any dangerous quantity of arsenic I must have found it.

4499. (*Mr. Cosmo Bonsor.*) We have it in evidence there was only one quality of beer brewed by Messrs. Groves that did contain arsenic. Possibly this particular beer you were analysing had no arsenic in it?—Of course it might not. In reference to the samples, Dr. Tattersall came to me in the evening and spoke about arsenic, and I told him in this particular sample I did not find any, and asked him to come and test with me the little I had left. I could not find the arsenic.

4500. (*Chairman.*) What quantity was the last test made with?—About one or two ounces of beer I had left.

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4501. (*Dr. Whitelegge.*) Did you use in the application of the Marsh test exactly the same methods you would rely on at the present day to find arsenic?—No, I did not. I have altered my method considerably. Of course, one was under the impression that an ordinary Marsh test was sufficient to find out arsenic.

Small numbers of samples of food and drugs submitted to P. analysts in certain districts.

4502. (*Chairman.*) With regard to the Borough of Stalybridge, you analysed seven samples of beer?—Yes, four of which contained arsenic.

4503. What is the population of Stalybridge?—I think about 60,000 or 70,000.

4504. Is not that rather a small number of samples to be submitted to you?—Yes. They only sent me 10 a year. They are going to send more now, I believe.

4505. Have you any information as to arsenical poisoning cases in Stalybridge?—No; only from these samples, four of which contained arsenic.

4506. In considerable quantities?—No, from 1-50th of 1-100th of a grain.

4507. (*Sir William Church.*) You say that you had ten samples of beer yearly from Stalybridge?—No, 10 samples of anything—butter, or anything.

4508. Did you ever have a sample of beer from them before?—Never.

4509. (*Dr. Whitelegge.*) May we take it that in all these cases where you found arsenic you gave instructions which led to the stoppage of the sale?—I did.

4510. In every district?—Yes.

4511. (*Chairman.*) With regard to the Borough of Birkenhead, during the last quarter of last year how many did you analyse?—I analysed 29 samples of beer, of which 11 contained arsenic.

4512. What quantities of arsenic?—I should say some of them must have contained 1-10th of a grain of arsenic to the gallon.

4513. And some smaller quantities?—Yes.

4514. But in respect to every one of the 11 you condemned it?—Yes. But no prosecutions were taken.

4515. There was stoppage of the sale?—Yes.

4516. Do you know whether any of those samples were brewed from Bostock's sugars?—No.

4517. During the present quarter you have analysed four samples of beer from Birkenhead?—Yes, and no arsenic was found in any of them.

4518. And the borough of Glossop at the end of last year?—I analysed 21 samples of beer, of which eight contained arsenic in more or less quantities. I should think not more than 1-50th to 1-100th of a grain for the less quantities.

4519. In every case was the sale of those beers stopped?—Yes. New samples were taken, and the new samples did not contain arsenic. They stopped the sale of it and obtained new samples from the publicans. They showed no trace of arsenic.

4520. By the same tests?—Yes.

4521. On the same quantities of beer?—Yes.

4522. What about Congleton?—I have had no samples from them.

No such samples in Congleton in 1900.

4523. Had you any reason why no samples were sent to you?—No; the Act is not enforced in Congleton.

4524. Have you received a great number of private supplies of beer malt, hops, etc.?—Yes. Some of the private samples of beer just contained mere traces of arsenic not worth speaking about, and two or three samples of malt have contained mere traces of arsenic, and the hops none.

Arsenic brewing material

4525. What tests have you used in these cases?—A similar test, by acting upon the malt with nitric acid and dissolving off the coating of arsenic, and then evaporating down and drying with sulphuric acid, and putting that into the Marsh apparatus.

4526. You speak of dissolving away the coating; was there a visible coating on the malt?—Only what may be called a dirt.

4527. That was malt before it had undergone brushing and screening?—That I could not say.

4528. Was it malt given to the brewer as ready for use?—Yes.

4529. You separated that crustation from the ???

. Bell. by dissolving it off?—Yes, by means of acid, and I treated that acid product in the Marsh apparatus.

. 1901. 4530. Then only in one sample of malt you found arsenic?—Yes. I have had two more samples since I wrote my *précis* where there were traces.

4531. How much might that be in a large quantity of malt?—It would be a most difficult thing to say. It is almost guess work.

4532. Do you consider that these traces might put enough arsenic into the beer to be dangerous?—No. This question of arsenic in malt must have been going on for years and years, because I have some samples of beer made from malt and hops in my cellar now which were sent to me about seven or eight years ago. I have just had a bottle of that analysed, and there is a trace of arsenic in that beer which was sent to me seven years ago.

4533. Were you requested seven years ago to test it for arsenic?—No. It was sent to me as a very pure beer.

4534. Had you ever heard it stated that beer sometimes contained arsenic?—Not till this epidemic.

4535. Had you no suspicion? In specimens of beer sent for analysis it would not be understood that arsenic was to be looked for?—No.

nic n jam. 4536. Then a large jam manufacturer near Liverpool submitted his makes of jam to you for examination?—Yes, I have analysed jams from a very large manufactory there, and there was not a trace of arsenic in any of the samples.

4537. Did he use glucose in his jam?—I cannot say whether he did. My attention was simply drawn to whether there was arsenic or not. It was at this particular time, and he particularly wished to know if there was arsenic present.

4538. Your test could not detect glucose?—Not at that time.

4539. Could any test you could apply detect glucose in the manufactured article?—Yes.

4540. Can you distinguish by your tests between glucose and the golden syrup or treacle or molasses of natural manufacture?—Yes, I can, most easily.

4541. You have no means of telling whether those jams were made by some of Bostock's sugars?—I did not test the jams themselves for glucose, but I have done so within the last fortnight, and there was no glucose in them.

4542. Did you ask the maker of the jam if they used glucose?—No, I did not; it was made of pure cane sugar.

4543. You have no reason to think that they used the Bostock glucose?—No, and as I found pure cane sugar, I did not ask him whether he had used glucose.

4544. What is your opinion as to the cause of the traces of arsenic in beer at the present time?—I consider that all the apparatus and implements of the brewery must have been saturated with arsenic from the use of Bostock sugar, such as the barrels, indiarubber tubing, pipes; and if these were not thoroughly cleaned out, it must naturally contaminate the beer.

4545. A small residue from the use of Bostock's sugar?—Yes. Even the very copper vessels would almost act as a Reinsch test; the arsenic would be deposited upon the copper.

ing ring 4546. (*Sir William Church.*) Have you seen the accounts of the investigation of the cleanings of the vats and barrels? You are aware that portions of the wood of vats have been cut out and examined for arsenic?—No, I was not aware of that. Was arsenic found?

4547. In hardly detectable traces?—I had a piece of indiarubber tubing sent to me from the brewery, and I passed a solution through that, and obtained arsenic.

4548. Attention has been directed to what you are now speaking of. The copper has been also searched for arsenic where Bostock's sugars have been used, and no trace was found?—One would have thought from theory that it would have been deposited on the copper, as it is one of our tests.

4549. (*Chairman.*) You think it desirable that a uniform method of testing beer or such like bodies for arsenic should be used?—I think there should be a uniform method of testing. At the present time every chemist has a different process. Only a short time since I had a sample of beer sent to me to examine, and I understood that one analyst had certified that it contained 1-5th of a grain of arsenic to the gallon; that is, five gallons of the beer contained one grain of arsenic. I certified that 15 gallons of the beer contained one grain of arsenic. It was sent to another chemist, and he certified that 40 gallons of beer contained one grain of arsenic. It was sent to the Somerset House authorities, and they certified that 30 gallons of beer contained one grain of arsenic. So that there is some difference.

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4549* A difference of from 5 to 40?—Yes.

Discrepancy in results of different analysts.

4550. The magistrates dismissed this case you mentioned?—Yes.

4551. Why did they dismiss it?—Because the discrepancies were so great. Forty to 50 gallons of beer containing so small a quantity is not very bad.

4552. But they would not have dismissed it if all the analysts had said 40?—That I cannot say.

4553. (*Dr. Whitelegge.*) Did you stop the sale in every instance of beer containing above 1-40th?—Yes. I certified at once, and sent to the inspector to tell him he had better stop it.

4554. (*Chairman.*) Is it certain that the magistrates dismissed a case in which four analysts found over 1-40th, or more than 1-40th, of arsenic?—That is a fact.

4555. I think that really should be on record, that the magistrates dismissed a case in which four chemists certified quantities of 1-40th of a grain per gallon or more?—Yes.

Prosecution for minute amount of arsenic in beer.

4556. If there was no other reason for dismissing the case, it hardly seems as if the safety of the public was taken into account by the persons who dismissed that case. Have other cases been brought before you?—There is another case I have just had before me, where a summons was taken out against a brewer for a trace of arsenic of about 1-100th grain per gallon. I examined it by my method and found the quantity was exceedingly slight, so slight that I should have practically passed it as a pure beer.

4557. Has this case gone forward?—It was to have come on on Monday, but I have not heard the result of this case.

4558. Was that submitted to the same magistrates as those who tried the previous case?—No; this one is in Wales.

4559. (*Mr. Cosmo Bonsor.*) Where was the other one where the magistrates dismissed the case?—Near Rochdale, I think.

4560. Was it a bench or a stipendiary?—A bench.

4561. (*Dr. Whitelegge.*) Your certificate was an official one?—No. This is not my official certificate. I am simply requested to analyse as against the official certificate. The county analyst gave this case as 1-5th of a grain of arsenic to the gallon; it was sent to another analyst, who found 1-40th. It was then sent to me, and I found 1-15th. It was then sent to Somerset House, who found 1-30th.

4562. (*Sir William Church.*) But in this case, in which proceedings have been taken, in which you found only 1-100th of a grain, do you know whether any chemist found a higher percentage?—No; he could not state the quantity, it was so infinitesimal. I saw the certificate, and there was no mention of any quantity.

4563. And yet proceedings were taken?—Yes. He could not estimate the quantity.

4564. (*Chairman.*) You would not think it right to prosecute for a quantity so small as 1-100th of a grain?—No, I should not. To me it is persecution, when the brewers are trying to do everything they possibly can.

4565. But supposing it was certain there was 1-40th, or not less than 1-40th, would you consider it right to prosecute in such a case?—I do not like doing it, but I think it ought not to be there. I do not like a prosecution for 1-40th where it is due really to the malt; and if the brewer is willing to change his malt and get pure malt, then I think, under the circumstances, a prosecution should not take place when the circumstances are inquired into.

Arsenic in all-malt beer.

4566. (*Sir William Church.*) How large a quantity of arsenic have you ever found in beer made from nothing but malt and hops?—I should put it at over 1-100th—that is to say, perhaps from 100 to 150 gallons of this beer would contain a grain of arsenic.

4567. You have not, perhaps, made any examination for that purpose? What is the largest quantity of arsenic you have estimated as occurring in beer made

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purely from malt and hops?—I cannot say that, because I do not know how these beers are manufactured.

4568. You have not had a beer brewed in that way given you for the estimation of the amount of arsenic?—Only this particular sample I have had myself for about seven years.

4569. It has been given in evidence before us that as much as 1-7th of a grain in a gallon has been found in beer that has been brewed from malt and hops?—I could not speak of that.

In malt.

4570. In your estimation of arsenic in malt, what is the largest quantity of arsenic you have found in any specimen of malt submitted to you?—I should say from my comparison tubes there could not have been 1-50th of a grain per lb. of malt.

4571. Do you know whether that was screened or unscreened malt?—I could not tell.

4572. (*Chairman.*) Have you any newspaper report of the case dismissed by the magistrates, though the Somerset House authorities found 1-30th of a grain per gallon?—I have not.

4573. It has been published I presume?—I should think so. I did not see it in the Manchester papers. I knew it by the chemist who had certified to the 1-40th writing to me and giving me the information.

4574. Could you tell Dr. Buchanan what newspaper he would find a report of that case in, or put in the chemist's letter?—I have not the letter now, but I will give you the chemist's name. I tore the letter up, but I can give you his name.

4575. We wish to have information as to the evidence given?—I will obtain it for you.

4576. This was all published?—I should say so; in one of the local papers—the Rochdale "Times" of March 16th, 1901.*

Tests for arsenic in beer.

4577. (*Dr. Whitelegge.*) You told us that you gave up the use of the Marsh test in the course of the recent inquiries into arsenic, and adopted another?—Yes. The Marsh test, where you just used the generating flask and allowed the gas to impinge on the cold porcelain. Now I have adopted a very different plan. It is what is called the Marsh Berzelius test.

4578. But still a modification of Marsh's test?—Yes.

4579. (*Chairman.*) Did you also use the Reinsch test?—Yes, the Marsh Berzelius and the Reinsch.

4580. Did you apply both tests on the same sample?—Yes; and when a prosecution is threatened I try it in three or four different ways.

4581. (*Dr. Whitelegge.*) What led you to discontinue the other form of Marsh's test? Was it not sensitive enough?—No, it does not show traces of arsenic at all.

4582. Is there any difficulty in detecting arsenic in beer, any complication?—I do not consider there is any if the test is worked properly.

4583. No special precautions needing to be taken?—I should not like to say that. An ordinary person could not test beer for arsenic. If you were to tell a lad to prepare some hydrogen gas he could prepare the gas, but if you were to tell him to test the beer for traces of arsenic he could not do it.

4584. You would not say it was easier to find it in beer than in water?—I should say it is easier to find it in water, decidedly so.

Beer not tested for arsenic before the epidemic.

4585. Your practice was similar to that of other analysts, I suppose, and until you gave special attention to the details of the analysis of beer for arsenic it is possible some were overlooked?—Quite so.

4586. And would you say that generally arsenic in the earlier stages of an inquiry of this kind would be overlooked in beer?—It would be.

4587. So that we must not attach too much importance to the absence of record of arsenic in the earlier stages?—No, I do not think so.

4588. Has it been your practice in former years to examine for arsenic?—I never did it before.

4589. Arsenic was not one of the substances that was recognised to be sought for?—No.

4590. Had you ever examined beer for arsenic?—Never.

4591. When you find arsenic in beer what do you report under the Sale of Food and Drugs Act?—I report on the certificate, "This beer contains a mere trace of arsenic," if it is a mere trace.

4592. What would that mean as a maximum?—It might be 1-100th or 1-150th of a grain.

Form of certificate by P. and when minimum quantity of arsenic found in beer.

4593. And certifying in that sense you anticipate that the local authority will not institute any proceedings?—I do.

4594. Supposing the arsenic is present to the extent of 1-50th, what do you certify?—I should certify that "This beer contains distinct traces of arsenic, in my opinion about 1-50th of a grain." I begin then to give quantities.

4595. Is your certificate written with the idea that the authority will take it into court?—Not always.

4596. If you found 1-20th?—Yes; I should write it so that the authority could take it into court.

4597. I gather from you that where there was more than 1-10th you considered the question of prosecution ought to arise. Have you found more than 1-10th in any sample?—In the early samples there was more than 1-10th, but the rush of work was so great then, and as I was told that they were not prosecuting, it was not worth while going on with the analysis

4598. Why do you draw the line at the 1-10th? Is there any general understanding that is the limit?—No, there is no understanding.

4599. You have to adopt some line of demarcation, and you fix it there, is that it?—No, I do not adopt any, if I find 1-20th or 1-15th. For instance, in this case I have just mentioned, where one analyst finds 1-5th and I find 1-15th, I said, "I cannot defend such a case as that."

4600. My point rather was that you make a distinction between more than 1-10th and less than 1-10th for practical purposes. Was there any particular reason for fixing on 1-10th rather than 1-15th or 1-20th?—Simply because I have my standard tubes made up to 1-10th, 1-20th, and 1-30th. If it is 1-10th of a grain of arsenic and another analyst finds 1-12th I consider that very close. I have just had one from Yorkshire where a chemist had certified to 1-12th of a grain. It was sent to another chemist, and he certified 1-25th. I have certified to 1-10th of a grain. I thought that was a case I could not defend. I found it correspond to my tenth standard.

Administration of F. & D. in different districts.

4601. Are you satisfied with the present administration of the Sale of Food and Drugs Acts?—Yes, I think I am. I cannot see there is much to complain about it.

4602. In the case of one of the boroughs of which you are public analyst no samples at all were taken?—Not any.

4603. Is that a proper condition of things?—Not at all. I have not had any from that borough for years, although I have been the analyst for fifteen years. During the last eight or ten years I do not suppose I have had a dozen samples.

4604. Do you receive any official instructions from the Local Government Board, or any Government authority, bearing upon your appointment?—No.

4605. Do the local authorities, within your knowledge, receive any instructions as to samples to be taken?—No.

4606. So that the local authorities have no official instructions as to the number of samples, the character of the samples, or the amount to be taken for a sample?—The Local Government Board know how many samples are taken.

4607. But have the local authorities instructions as to the number of samples?—They are supposed to take one sample per 1,000 people.

4608. Where is that laid down?—I have seen it in print, but I cannot exactly say whether it is the law. That is the rule.

4609. It is a rule that is very largely not observed?—Exactly.

4610. You cannot refer me to any official instructions of any kind?—No. I may say that when I think there is anything particularly likely to be adulterated I write off to my inspectors and tell them they had better get some samples of these various things in. In the beer case, I immediately wrote to Chester, when I heard about the beer question in Manchester and Salford, that it would be wise to get some samples all over Cheshire, and they did so immediately.

4611. To what inspectors are you referring?—The county inspectors of Cheshire.

* Concerning this prosecution, at Rochdale, see evidence given by Mr. William Marshall Q. 5324-8.

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4612. Inspectors of what?—Under the Sale of Food and Drugs Act.

4613. Are they inspectors of police?—No, special inspectors. In the county of Chester it is all under a chief inspector and four sub-inspectors, and they have to get these samples from all over the county. The number that they bring me in in a year is about 1,000.

4614. Do you instruct them?—No, I do not, except on special occasions when I knew that there was some adulterated thing in the market, and then I should say, "You had better get some of that."

4615. Do you tell them how much to get?—Yes.

4616. You told us in the case of beer that when you found notable quantities of arsenic you gave instructions which led to the stoppage of the sale?—I did.

4617. To whom did you give those instructions?—To the inspector that sent me the sample.

4618. That would be in the county of Cheshire?—Yes.

4619. To whom in the case of the other authorities for whom you act?—In regard to Stalybridge I write to the chief constable. In regard to Glossop I write to the inspector of weights and measures. In regard to Birkenhead there is a chief inspector under the Sale of Food and Drugs Act, a chief sanitary inspector I think he is called. And then the Salford inspector comes to me two or three times a week so that I should verbally tell him what I wanted.

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4620. In no case does the instruction go through the medical officer of health?—No.

4621. Not even in Salford?—No.

4622. This year you say no arsenic was found in beer in Birkenhead?—No.

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4623. With reference to the last part of your evidence, you think that the proceedings ought not to be taken in case the amount of arsenic is small, say, 1-10th of a grain per gallon, and the brewer is willing to change his malt?—I think so.

4624. Would you suggest that the brewer should remain satisfied with 1-100th of a grain per gallon until such time as the analyst observed this for him, and then he should express his willingness to change his malt? Is there no antecedent precaution the brewer ought to have taken? We have had brewers before us who have asked for and received guarantees that all malt supplied to them is free from arsenic. If the brewer is producing a beer which contains 1-100th of a grain per gallon, would it not be incumbent upon him to show not only that he was intending to take, but had been taking, due precautions in the way of guarantees and certificates?—When he is informed that his beer contains 1-100th of a grain of arsenic per gallon, he should be informed that his malt must contain arsenic.

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4625. Is not that rather late in the day? Ought he not to have found that out for himself before? Do not you think it is incumbent on the brewer to take all possible precautions?—Yes.

4626. To get this malt as free from arsenic as possible?—Yes; and I believe the majority of brewers do.

4627. But I understand you to put it rather that if the brewer was willing to change his malt it was not necessary to attribute any blame to him?—In this way: I put it that if his beer contains this minute quantity of arsenic he should be informed about it and told that he must change his malt. I do not think it is necessary to prosecute for 1-100th of a grain.

4628. But do not you think the brewer is to blame if he has not taken measures to secure malt as free from arsenic as practicable before this?—Certainly he ought to have taken precautions.

4629. (*Chairman.*) Should not he find the arsenic, if there is any, in the malt before brewing with it?—His chemist ought to.

4630. It would be an easier test to find arsenic in the malt than the amount that could be possibly produced in the beer?—Yes.

4631. Would it be a difficult test for brewers to undertake in their own works?—Brewers could not do it. They must have a proper qualified chemist to do it.

4632. But large brewers do have chemists?—Yes.

4633. And analytical laboratories?—Yes.

4634. And smaller brewers can send out to a trustworthy chemist?—Yes.

4635. Would it be very embarrassing to the brewer that he should himself get direct authority that the malt he is using is free from arsenic?—It would be no trouble at all.

4636. Would it be much expense?—No; certainly not.

Mr. Herbert N. Morris, called; and Examined.

H. N.
orris.

4637. You are a chemical manufacturer at West Gorton?—Yes.

4638. And a Fellow of the British and German Chemical Societies?—Yes.

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tone,

4639. You manufacture sulphuric acid from brimstone?—Yes; for two years myself, and for many years it has been manufactured at the works that I now own.

4640. The brimstone sulphuric acid which you now manufacture has been made at the same works continuously for over 30 years?—That is so.

4641. How much per week do you make?—Over 50 tons per week.

4642. A large proportion of your sulphuric acid is used by mineral water manufacturers?—Yes.

4643. Do you make any speciality of this acid for use in the manufacture of food-stuffs and beverages?—Yes.

4644. Are there other manufacturers of brimstone vitriol in Manchester?—Yes, two other manufacturers.

4645-6. Do you consider that such sulphuric acid made by a good manufacturer and certified pure would be pure enough to be used for food-stuffs?—I do.

4647. Can you give the percentage of the total acid manufactured in this country which is now made from brimstone?—Only a small percentage is made from brimstone now in this country.

4648. Do you know how much percentage?—Probably not more than 5 per cent.

Sicilian
stone or
oxide.

4649. What do you mean by brimstone?—I mean Sicilian brimstone and brimstone that has been recovered, and which contains from 98 to 100 per cent. of pure sulphur.

4650. So that sulphur recovered from chemical processes you put in the same category with Sicilian sulphur?—I do.

Mr. H. N. Morris.

4651. Which do you trust most, the Sicilian brimstone or brimstone recovered from chemical processes?—I consider a brimstone which is dissolved out of oxide by means of carbon di-sulphide, which I have tried and which I find to be quite free from arsenic, is the safest source of acid.

4652. Safer even than Sicilian brimstone?—Yes.

4653. Have you found arsenic in any specimens of Sicilian brimstone?—I have found minute traces.

Arsenic in Sicilian brimstone.

4654. What do you mean by spent oxide?—I mean by that the oxide from gas purification.

4655. Not from any other source?—No.

4656. And your recovered brimstone is entirely from gas purification?—Yes. I have some of it here. It is crystallised out in fine crystals from carbon di-sulphide. As this is a product that is not largely used and that has only recently been introduced into the market, I have brought this sample to show you the nature of this brimstone.

4657. This is very unlike in appearance Sicilian sulphur?—Yes.

4658. This is greenish, and Sicilian sulphur is yellow?—That is also yellowish.

4659. Could you distinguish by eye immediately between sulphur from spent oxide and Sicilian sulphur?—I could.

4660. By the colour?—By the colour and the small crystallised nature. This is obtained in small crystals, while the Sicilian brimstone occurs in lumps, and not in crystals at all.

4661. If you break those lumps, and examine them by a lens or microscope, are they crystallised?—Yes.

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4662. Do you never get this in lumps from the spent oxide?—No.

4663. (*Sir William Church.*) It is like this when you recover it from the spent oxide, by the sulphide of carbon process, but if it is recovered in other ways you get it in larger masses?—Yes.

4664. Very much like Sicilian sulphur?—Yes.

Difficulty in uniformly de-arsenicating pyrites acid.

4665. (*Chairman.*) Why is it that so small a percentage of the total acid made in this country is made from brimstone?—One reason is that the quantity of arsenic and iron that is contained in the acid made from pyrites and oxide, which are the chief sources of the acid in this country now, has not been hitherto considered harmful or deleterious.

4666. Is it now considered harmful or deleterious?—Yes.

4667. Essentially so?—Essentially so.

4668. Cannot it be purified to deprive it of harmful qualities?—Yes.

4669. Is that a very expensive process?—It is not necessarily a very expensive process, but it needs very great care and supervision, and as it is carried on at week ends and nights, the manufacture of sulphuric acid being a continuous process which cannot be stopped, it makes it additionally difficult to completely control the process.

4670. The purification of the acid takes place after the regular manufacture has been completed?—That is so.

4671. So that the whole of the sulphuric acid which has passed through the process will need to pass through a second process to purify it?—That is so.

4672. Does that add much to the cost per ton?—Not very much; a few shillings per ton.

4673. A few shillings on how much money?—On £2.

4674. It might add 5 per cent. to the cost?—Yes.

4675. You make a speciality of acid for food-stuffs and beverages?—Yes.

4676. You do not yourself make it by the pyrites process?—I do not. I have made sulphuric acid for eight or ten years from pyrites, both Welsh, French, and Spanish, and also from oxide, and I now make it from brimstone only, because I have come to the conclusion that that is the only safe method to use for making acid to be used for food-stuffs.

4677. You consider that, with the most careful purification practicable, acid made from pyrites is not safe?—It has always an element of danger in it, inasmuch as workmen can mix one bottle with another in the works where two qualities are made, and carelessness of workmen in the purification process cannot be always checked. It can sometimes very largely, with careful supervision, but I consider it to always contain an element of danger.

4678. The pyrites process is decidedly cheaper than the brimstone?—That is so.

4679. And by adding sufficient precautions for safety, which would necessarily cost money, could you for the same money produce perfectly safe sulphuric acid from pyrites?—I should adopt either that method or the oxide method if I thought that it would not be risky, because it would be cheaper for me to manufacture in that way than to use a more expensive article, which brimstone is from whatever source it is obtained. It is always more expensive than pyrites and oxide.

4680. It would be cheaper for you to manufacture from pyrites and purify with great care than to make it as you do?—It would.

4681. But you consider that, with all the care, you could not make it so safe?—I think it is safer by using the pure ingredients to start with.

4682. Do you know the difference between the apparatus, and the dimensions of the apparatus, used in Germany for making acid from pyrites and the processes in England?—I have been through some of the largest works both in this country, in Germany, and in Switzerland, and I am thoroughly acquainted, I think, with all the well-known processes used in connection with the manufacture of sulphuric acid.

Acid made from pyrites in Germany.

4683. The German process differs from the English in making pyrites acid, I believe?—There is one process that has recently been patented by the Badische Company in Germany, which, so far as I know, is not used in this country, which is essentially different from our methods of manufacture.

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4684. Is it the case that a large proportion, or perhaps the whole, of the sulphuric acid made in Germany hitherto has been made from pyrites?—That is so, and by the same process as it is made in this country.

4685. Do you know of any making of sulphuric acid in Germany from Sicilian sulphur?—I cannot speak about that.

4686. But certainly the greater part of sulphuric acid made in Germany is made from pyrites?—That is so.

4687. Do you know if that is purified from arsenic after the manufacture from the pyrites?—It is.

4688. In Germany it is habitually purified?—Yes.

4689. (*Dr. Whitelegge.*) Invariably purified?—No, not invariably.

4690. (*Chairman.*) Then some of the German sulphuric acid contains arsenic?—Decidedly, a very large quantity of it. I cannot speak of the percentage of the acid that is sold in Germany which contains arsenic, but certainly a very large proportion of it contains arsenic, and arsenic in large quantities.

4691. It has been stated before us that the German pyrites process differs from the habitual English pyrites process in the dimensions of the furnace and flues; it has been said that in the German pyrites process the fumes are led through a longer flue, and that arsenic is deposited on the flue before it comes to the condensing chamber, whereas in the English pyrites process the fumes are brought more directly to the condensing chamber, and contain therefore more fumes of arsenic?—That is not so. There is one process which is used in Germany which differs essentially from our English processes, and by that process the gases from pyrites ovens are passed through a very elaborate system of purification before entering into what is called a contact chamber of platinum, which is used for making the acid.

Badische process.

4692. To condense the fumes?—Yes, in the platinum vessel, and if there are any impurities in the gas used in this process they would act on the platinum. That process is a recent one, and can only be erected on a very large scale such as is used in Germany. I believe it is not used in this country as yet.

4693. Is that under the Badische patent?—Yes.

4694. Does that give very pure sulphuric acid?—Yes.

4695. Quite free from arsenic?—I have not examined any acid made by this process. So far as I know it is only made successfully at that one factory on the Continent.

4696. In the habitual German manufacture hitherto is there any difference, in respect to the length of the flue, from the English process?—Nothing notable, with the exception of that process I have named.

4697. That is a new process under the new patent, but the ordinary process is substantially the same as the English?—Yes.

4698. And the gases are brought into the leaden chambers where the sulphurous acid is converted into sulphuric acid. Is the temperature of the fumes coming into the leaden chambers practically the same in the German process and the English process?—It is.

4699. Consumers of sulphuric acid, who are very often not chemists, have not been aware of any difference in quality between pure and impure acids?—That is so.

4700. And have been misled by advertisers offering acid made from sulphur?—That is so.

Trade meaning of sulphur acid.

4701. Is there any evidence, except in Nicholson's case, that pyrites acid is sold as sulphur acid, whether purified or not purified?—I speak from memory now, but I am under the impression that I have seen another advertisement offering acid made from sulphur which has not been made from sulphur, but from pyrites. I was under the impression myself that the firm that advertised did actually make at least a certain proportion of their acid from sulphur.

4702. You know of just that other case beside the Nicholson's case?—Yes; one other besides Nicholson's.

Arsenic in Sicilian brimstone and spent oxide.

4703. You told us you used Sicilian brimstone and brimstone extracted from oxide by means of carbon di-sulphide; and the latter you find the most reliable as regards freedom from arsenic?—I do.

4704. Did you never find more than a slight trace of arsenic in Sicilian brimstone?—No.

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4705. Have you found any trace of arsenic in acid made from Sicilian brimstone?—I have, a trace. I have Marsh tubes here showing the relative proportion of arsenic in acid made from the different sources. For a considerable time I used nothing but Sicilian brimstone, and I have the test showing acid made from Sicilian brimstone, which contains a faint trace of arsenic. (*Specimens shown to Commission.*) You can only see a slight film. All these tests are made by taking 25 cc. of the acid and diluting to 250 cc. of water, pouring all these contents into a flask containing 30 grams of zinc, and working for one hour, which is the time required to expel practically all the hydrogen. This method I have found to work very satisfactorily, giving a uniform small flame of ¼in. to ⅜in. long.

4706. That is the Marsh test?—Yes. After having the chambers full of acid made from this recovered sulphur I have mentioned, I had a test made in the same way, and that is the result. In that case there is no film. (*Specimen shown to Commission.*) I have also had this analysed by many analysts, and most of them have pronounced it perfectly free, and one or two have said that they have found a slight trace.

4707. A slight trace in the acid made from the Sicilian brimstone?—No, from the recovered brimstone. Most of the analysts who have analysed this for me, in addition to my own chemist's test, have pronounced it absolutely free, but one or two have said that they find minute traces.

4708. If you were trying the same test on a much larger quantity of acid, could you get a larger result?—Yes; that would show a little plainer.

4709. Can you give any estimate of what the quantity shown here would be per litre of the acid?—No: it is so small that I do not think any estimate could be made, whatever quantity is used. I have comparisons with exactly the same test made with other kinds of sulphuric acid. (*Specimens shown.*) These are from two makes of spent oxide from gas works.

4710. That is sulphur from spent oxide?—No, the spent oxide itself. That is used very largely in this country for making sulphuric acid now.

4711. Do they call that brimstone acid?—No.

4712. B.O.V. means brown oil of vitriol?—Yes.

4713. When you hear workmen talking of stone acid, is that brimstone acid?—No. Oxide acid is considered to be free from arsenic, and is stated by some people to be free from arsenic. But I find it contains a considerable quantity. These are the tests which I have made.

4714. From 25cc. of acid?—Yes. When you compare those specimens with pyrites acid you will see there is a marked difference. These contain comparatively only traces of arsenic.

4715. You use sulphur from spent oxide?—The sulphur is extracted and precipitated.

4716. In the manufacture of sulphuric acid spent oxide is burnt and its fumes used?—The spent oxide itself is burnt in the same way as pyrites, in ovens similar to pyrites ovens.

4717. Spent oxide may give some arsenic to sulphuric acid, but pyrites still more?—Yes. This is the ordinary pyrites acid test. (*Specimen shown.*) Those are crystals of arsenious acid.

4718. The silver-coating is what?—Metallic arsenic.

4719. And the black is what?—Metallic arsenic also. That is the ordinary pyrites acid of commerce without having been purified.

4720. Then the manufacture of acid shown here from oxide and here from pyrites is by the same process?—Yes.

4721. The cheapest acid is made from the pyrites?—Yes.

4722. And what would be the expense of making acid from oxide?—It is dearer than pyrites acid, but not so costly as brimstone acid.

4723. Is any of this oxide acid sold by the manufacturers as being brimstone acid?—Not that I am aware of.

ic in s acid.

4724. How much per litre would give such effect as this specimen from pyrites acid which you show?—The actual percentage of arsenious acid is 1·6 per cent. by weight—1·6 grammes per 100 grammes of the acid.

4725. Can you tell how much there might be in this other specimen of pyrites acid?—I have not estimated the quantity. It is small.

4726. Considerably less than 1 per cent.?—Considerably less—probably less than 1-10th per cent. Here is a specimen 1 per cent. of pyrites acid in pure acid—that is to say, this is pure acid mixed with 1 per cent. of pyrites acid. You have there an example of the adulteration that 1 per cent. of this pyrites acid makes.

4727. (*Dr. Whitelegge.*) What form of pyrites acid was that? Would it be tower acid?—Yes.

4728. (*Chairman.*) When there is so great a quantity as 1·6 per cent. is the arsenious acid dissolved in the sulphuric acid?—Yes.

4729. How much arsenious acid could you dissolve in sulphuric acid?—I have never tried. I do not know what a saturated solution is.

4730. But it is freely soluble?—Yes.

4731. It is not known how much?—I think not. I certainly do not know.

4732. 1·6 sounds enormous. Do you think it would dissolve 10 per cent.?—I think not.

4732*. Is it possible that some arsenious acid would be deposited in time in that acid if it were to stand?—If this acid stood for some time it is possible the arsenious acid would crystallise out slightly. It seems to have that property.

4733. B.O.V. contains other impurities besides arsenic?—Yes.

4734. Does the arsenic combine with some of the other impurities or dissolve in the sulphuric acid independent of the other impurities?—I think it is dissolved independently of the other impurities.

4735. (*Sir William Church.*) Are you acquainted in the trade with brown oil of vitriol which contains a deposit of arsenious acid?—I have never, until this has been mentioned in the inquests on the beer poisoning cases known arsenious acid to crystallise out from sulphuric acid in commerce. I have known a deposit of sulphate of iron out of the acid.

4736. (*Chairman.*) If you leave a jar of brown oil of vitriol for weeks or months does the glass become incrusted with something deposited from the acid?—Yes, it does.

4737. If you pour it into another glass will the acid be cleared?—Slightly cleared.

4738. Would filtering make any difference to the brown oil of vitriol?—I think not.

4739. It would go through, colour, arsenic, and all?—Yes, I think so.

4740. Is arsenious acid nearly as soluble in water as in sulphuric acid?—It is not.

4741. Take the sulphuric acid containing 1·6 per cent. of arsenic. If you mix a very large quantity of water with it would that deposit the arsenic?—I should think so. I have not tried it.

4742. It might still be dissolved in the highly dilute sulphuric acid or might be deposited?—Yes, and it might be present as arsenic acid, which is a liquid.

4743. Is there any arsenic acid in the sulphuric acid?—I think it is present as arsenious acid.

4744. It could not be arsenic acid without more oxygen?—No, it could not. I have here two examples of the purified pyrites acid. The first contains only a small amount, and is nearly as pure as the samples of brimstone acid, but the second one contains a fair quantity. (*Specimens shown.*) That was bought by me some time ago, and I asked for some acid specially well purified and free from arsenic, and this is what I got, containing a considerable quantity. I wrote to say it contained a considerable quantity, and I got a further lot, which you see is very much better.

4745. After your first inquiry they probably purified it further?—They took more care in purifying it.

4746. But this first specimen demonstrates the unsatisfactoriness of the de-arsenicated process?—That is so.

4747. Unless purified with extreme care?—I think so.

4748. (*Dr. Whitelegge.*) In recovering sulphur from the spent oxide by bi-sulphide of carbon, is there any danger of taking over the arsenic in the solution?—No, arsenic is not soluble in carbon bi-sulphide.

4749. (*Sir William Church.*) Would you consider that using the Sicilian sulphur would excuse you, as a manufacturer of sulphuric acid to be used in the preparation of food stuffs, from examining it after manufacture?—Certainly not; it never has done.

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4750. Therefore even the acid made from Sicilian sulphur would require to be examined after manufacture before it could be guaranteed pure?—That is so, if a guarantee be given. I do that. I have a special form.

Arsenic in Sicilian brimstone.

4751. I am not doubting that you do that. Is it not also the case that sometimes you get a very considerable trace of arsenic in Sicilian sulphur? Pockets are come across in which there is a large quantity of arsenic?—I have never come across a pocket of arsenic in Sicilian brimstone. Such things do occur; they are facts; but even if a pocket of arsenic were present in a delivery of Sicilian brimstone that quantity when it got into the chambers would be so very much diluted, generally with at least 100 tons of sulphuric acid in the chamber process, that even in that case it would not render the acid unsafe, but would still only appear as a mere trace.

4752. (*Chairman.*) Is the pocket visible to the eye?—I understand that it is not larger than the fist.

4753. That pocket would contain what materials?—A large percentage of arsenic.

4754. Not all arsenic?—No.

4755. Would half the mass be arsenic?—It might be half the mass.

4756. That would be a very large quantity to be mixed up with the acid?—That is so. With 100 tons of acid it would have to pass in the form of vapour, and in that case it would be infinitesimal. I do not think it would be detected in the acid as making a marked difference.

4757. (*Sir William Church.*) If that is the case, what is your object in examining your acid after manufacture?—It is simply in giving guarantees to customers. I have to give guarantees, and in order to do that it is absolutely necessary to test every delivery. I have not only to do that, but for some customers I have to examine each carboy.

4758. If this is done, the only reason why acid made from pyrites would be less safe would be the possibility of the mixture of the carboys?—That is so.

4759. If you had to test your acid after you had manufactured it, and if the manufacturer from pyrites tested his acid too, the danger would be only in the mixture of carboys, carboys of impure acid getting delivered as carboys of pure acid?—That is so; but there is also another thing to consider—that a chemist, if he found a small quantity of arsenic in the purified pyrites acid, might pass it without the knowledge of his employer, and the employer might have a heavy claim against him for damages if it were found out. There is a double risk in using that process.

4760. Is there not also a risk that, not you, but other maunfacturers of brimstone acid may give their guarantee without a careful analysis when they use such good materials?—I have considered the risk, and I certainly find the risk in using the purest materials that could be obtained for the manufacture of the article is the slightest.

4761. That, of course, one accepts at once. I only suggest that where a person was in the habit of using such pure materials that no contamination was found in the manufactured article, that the analysis of that manufactured article would be likely to be less carefully conducted than where it was known that certainly there was a risk of it?—Yes, there is the possibility, of course.

4762. (*Chairman.*) The pockets of arsenic of which you spoke are very rare?—Extremely rare; although I have used hundreds of tons of Sicilian brimstone I have never seen one of these pockets in the sulphur.

4763. It would be manifest in sulphur of the size that you use. What sized pieces do you use?—It is broken into pieces the size of one's fist.

4764. So that a large portion could not escape observation?—No.

4765. Is it a different colour from the rest of the sulphur, and a common workman shoving it in with the shovel would see it?—Yes, it would be a curiosity to him.

Guarantees of brimstone acid as arsenic-free.

4766. But you have never found such?—I have never seen it. I have read of it as a scientific fact.

4767. (*Mr. Cosmo Bonsor.*) Do I understand that you give a guarantee with every delivery of acid you send out?—I guarantee that it is made from brimstone and that it is free from arsenic.

4768. A double guarantee?—Yes.

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4769. (*Chairman.*) Do you make a test?—I put it on the invoices. It has to be initialled by the chemist who tests it before the invoice is sent out.

4770. The finished product?—Yes; it is possible that a dirty vessel might be used to fill it into. That is an additional precaution of testing the article before it goes out of the works.

4771. (*Mr. Cosmo Bonsor.*) How long have you been giving that guarantee—ever since you have been in business?—Ever since I have had these works. I have had labels like these:—"Pure Brimstone Vitriol."

4772. Have you to send the guarantee free from arsenic?—No.

4773. Not till lately?—No.

4774. Since the epidemic?—Yes; but all along these kind of labels have been put on.

R. O. V. B. O. V.

4775. (*Chairman.*) Have you a process of rectification besides the manufacture from pure brimstone?—Yes; I have two classes of labels. Some of them have "Brown" at the bottom, which means B.O.V., and others mean R.O.V.; it means this is 98 per cent., whilst the brown is 80 per cent. of sulphuric acid, the rest being water. It has not been concentrated.

4776. Does brown indicate other impurities?—Organic matter.

4777. The rectified is purified of the organic matter?—Yes; it is distilled.

4778. There are some volatile gases in ordinary sulphuric acid. Are there any volatile matters in this brown oil of vitriol?—There are compounds of nitrogen which are expelled in the rectification, and in the rectified acid I have to give a guarantee that it is free from nitrogen compounds and from arsenic.

4779. To be used for a drying agent in chemistry it must be freed from these volatile products?—Yes.

4780. (*Chairman.*) What is the specific gravity of the B.O.V.?—Spec. grav. 1·75 or 80 per cent., and the rest water.

4781. Do you have 100 per cent. of acid?—No; it is not possible to get sulphuric acid 100 per cent. You cannot get more than 98 per cent.

4782. As a drying agent, what percentage of sulphuric acid would there be?—98 per cent.

4783. (*Dr. Whitelegge.*) Which acid do you supply for the manufacture of food substances?—The R.O.V., and that which is free from lead. The R.O.V. is not free from lead.

4784. (*Chairman.*) How much more does this acid cost than the first product?—Twice as much as the B.O.V. The purification of the lead and the rectification make it twice the price.

4785. On the label you mention arsenic?—Yes.

4786. You did not mention arsenic on the labels previous to this scare?—No; I did not mention it in the guarantees.

4787. A label satisfies which contains the word arsenic, but your corresponding label did not contain the word arsenic a year ago?—No; it was only guaranteed made from brimstone.

4788. (*Dr. Whitelegge.*) You did not mention lead before the epidemic, did you?—No.

4789. (*Chairman.*) It has been always a speciality of your works to make the acid free from arsenic?—That is so.

4790. Before this epidemic occurred?—Yes.

4791. You considered arsenic before the epidemic occurred?—Yes.

4792. Was it regularly tested for that impurity before the epidemic?—Yes.

4793. Even before the epidemic you tested all the sulphuric acid that you gave out as pure for arsenic?—Yes.

4794. Years ago?—Yes.

4795. (*Sir William Church.*) And lead?—No.

4796. But surely the danger of lead was very much greater than the danger of arsenic?—But in the processes lead is generally precipitated, and the clear liquor drawn off. I believe in sugar making that lead does not matter as an impurity, because in the process used the lead is deposited and the clear liquor is drawn off, and contains no lead. Some people require it also.

free from lead, and to those who ask for it free from lead I send them the quality I have shown you.

4797. (*Chairman.*) But you would not approve of it being used for food-stuffs unless purified from lead?—I do not guarantee it. Where people have written asking me to guarantee the acid free from all impurities, I always replied before sending any that my common acid is free from arsenic and nitrogen compounds, but not from lead. It contains a trace of lead, and that if they wish it freed from lead they must have the other quality, and I mention the price.

4798. The lead will be in the form of sulphate of lead dissolved in sulphuric acid?—Yes.

4799. The trade journals for some years have warned the makers of beverages against the use of impure sulphuric acid?—Yes.

4800. You have extracts from the "Mineral Water Trade Journal," September 17th, 1895?—Yes. In 1895 there was an article in the "Mineral Water Trade Journal on the "Purity of Mineral Waters," which I can read: "The purity of Mineral Waters," they say, "The attention which the mineral water trade is exciting in the London dailies and in all parts of the country, consequent on the agitation against the interference of the military in competition with civilian traders, leads us to the consideration of the important question of the purity of the beverages so popular with our countrymen. The purest mineral waters are produced by using vitriol made from brimstone, and no other kind should be used. The advantage to be gained by this is, that it is absolutely free from arsenic, whereas the common quality of vitriol is made from pyrites which contain a large amount of arsenic, and, consequently, should not be used in the manufacture of a table drink." That was in 1895, and in 1900, on August 17th, in a leading article in the same journal, it said: "The question of arsenic, as an impurity in vitriol, is of the utmost importance, and it is needless to tell our readers that cases have frequently occurred of arsenic poisoning through drinking mineral waters containing even traces only of that injurious substance, sometimes with fatal results. It is almost impossible to completely purify common vitriol made from pyrites, from arsenic, and we should advise all mineral water manufacturers to give this matter their serious consideration."

4801. Do you yourself know what cases are alluded to?—I do not.

4802. (*Mr. Cosmo Bonsor.*) Did you write that article?—I did not. This is a leader.

4803. (*Sir William Church.*) A leader from a trade journal?—Yes, the "Mineral Water Trade Journal."

4804. Have you any knowledge of whether that is true, that cases frequently occur of arsenical poisoning from drinking mineral waters containing only traces of that injurious substance?—I have read myself in the paper of a case in France two or three years ago. I do not remember the particulars now. The mineral waters had been the cause of arsenical poisoning in that case. I do not remember the paper now, but it was pointed out to me at the time.

4805. Have any cases ever been recognised in this country?—I do not know; this was in France.

4806. There have been cases of disease recognised as occurring from mineral waters in this country?—I cannot say with certainty about that.

4807. Are not you aware there have been many cases in which lead poisoning has arisen from mineral waters?—Yes.

4808. I have never heard of a case of arsenical poisoning; I will not say they have not been recorded; but there have been cases of lead poisoning?—Yes.

4809. (*Dr. Whitelegge.*) How does the arsenic get into the mineral waters from the sulphuric acid?—I do not know exactly the processes that the mineral water manufacturers adopt, whether any of them use the sulphuric acid direct; that is, bring it in contact with the beverage that is drunk. It is possible they do.

4810. If they only use it for generating the carbonic acid gas?—Then, unless they use a metallic vessel for generating that gas, or some metal gets in, they are not likely to get the arsenic over with the carbonised gas. I know that sulphuric acid is used by workpeople as a drink in summer. I have known workpeople for the last ten years every summer to put a few drops of sulphuric acid in a glass of water and drink that in preference to plain water. It gives the water just a sour taste.

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4811. You have examined a good many samples of acid made from spent oxide?—I have.

4812. Has your experience in general been as unfavourable as in the particular instances you have shown us? Would you say that spent oxide generally contained notable quantities of arsenic?—Yes.

Arsenic in spent oxide acid.

4813. And that acid made from spent oxide is usually largely charged with arsenic?—That is to say, largely charged? I do not consider these specimens I have shown you to be large quantities.

4814. But do you think them fair samples?—I think one of them is above the average as regards purity, whilst the other one is rather below the average. One of them is bad, and I have not found many as bad as that. One of them, however, is better than the average.

4815. (*Chairman.*) Where does the arsenic in the oxide acid come from?—It must come over from the bog ore which is used for purifying the gas, and which absorbs the sulphuretted hydrogen, or from the pyrites in the coal, which is carbonised, and must pass, in that case, along with the sulphuretted hydrogen as arseniuretted hydrogen, and be absorbed in the gas purifiers.

4816. What do you mean by bog ore?—Bog iron ore; a hydrated oxide of iron which is used for absorbing the sulphuretted hydrogen from coal gas.

4817. And is it liable to contain arsenic?—I think so. That is one reason I give for the acid containing arsenic.

4818. We should like to have on record the prices of oil of vitriol?—My selling prices for brimstone vitriol at my works, last year, were: B.O.V., 35s. to 40s. per ton; R.O.V., £3 15s. to £4 per ton. The selling prices of pyrites acid were: B.O.V., 25s. to 30s. per ton; R.O.V., £2 15s. to £3 5s. per ton. During the last few years I have bought for an aniline dye manufacturer large quantities of pyrites, B.O.V. at 28s. 6d. per ton, delivered into consumer's works, half a day's carting distance, and so-called non-arsenical acid at 32s. per ton, delivered nearly a day's journey.

Prices of commercial sulphuric acid.

4819. You have tried 100 samples and consider that brimstone vitriol made from either of the sources you have mentioned is absolutely safe for use in the preparation of articles for human consumption so far as arsenic is concerned?—That is so.

4820. Selenium is said to occur in pockets in Sicilian brimstone. Have you met with selenium?—Selenium is a substance about which so little is known, and the distinctions between selenium and arsenic are so difficult to make out, that I am not able to say anything about that.

Selenium in sulphuric acid.

4821. Would it not show in the colour in the Marsh test, or in the Reinsch test?—I have bought chemically pure selenium and dissolved it in sulphuric acid, and applied many tests for arsenic to that sulphuric acid, and I have found that it gave all the tests almost exactly the same as arsenic. But I am not able to say whether that selenium was pure or whether it contained arsenic, which is, in my opinion, a very liable contamination.

4822. (*Dr. Whitelegge.*) Was your sulphuric acid free from arsenic?—Yes, it was quite free.

4823. Was the selenium deposited in the tube as a brick-red colour?—No, it was brown, and I got very large deposits.

4824. (*Chairman.*) Not more red-looking than the arsenic?—Not much.

4825. Do you consider then that selenium would show practically the same as arsenic in these tests?—I am not able to speak with certainty about selenium, because so little is known about it. I have tried to get as much information as I could about it, and about methods of testing selenium and selenium products, but there is so little published, and so little has been done with it, that I cannot say anything definite.

4826. (*Sir William Church.*) You had no experience of it before this poisoning scare?—I worked with it before this poisoning scare.

4827. With what object?—I started a research on the properties of selenium and selenium compounds, but I had not time to complete it.

4828. An independent research?—Yes; it was because so little was known of selenium and so little was published in the literature that I was undertaking some research work.

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Brimstone-acid not de-arsenicated.

4829. Those were purely scientific researches, not in any way connected with your occupations as a manufacturer and chemist?—They were not.

4830. (*Dr. Whitelegge.*) If you examined samples of your sulphuric acid for arsenic and found a trace of arsenic in it, what would you do: would you purify it?—No, I should send it to bleachers or dyers, who also buy from me.

4831. (*Sir William Church.*) Therefore, there is a chance of your carboys getting mixed the same as in an ordinary manufactory?—No, the quantity of impurity is so minute in any of these tests that it is only a question one might say of degrees of infinity.

4832. Clearly if you do put any aside as not being pure acid there is the same risk of carboys getting mixed in your works as in others? Perhaps not so great a risk?—As a matter of fact, I have never put any aside for impurity through arsenic, but only through nitrogen compounds and lead, and these are not of consequence in the manufacture of glucose.

4833. (*Mr. Cosmo Bonsor.*) Did you ever supply Bostock's?—No.

4834. Did you call upon them?—I have quoted for them.

4835. Over the price?—A little over.

4836. Your price was a little higher?—Yes, slightly; I believe about two shillings per ton.

4837. Do you supply sugar refiners at all?—I supply people who use it for the same process as sugar refiners, or manufacturers of invert sugar.

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4838. Is this acid used at all in the process of making flaked malt, do you know?—Not to my knowledge.

4839. It is purely for the conversion of sago and rice into glucose?—Yes, into glucose and vinegar.

4840. Distillers used it considerably, too, do not they? Do not they convert their maize and other grains in that way?—I believe so.

4841. Do you supply any of them?—No, not distillers.

4842. (*Chairman.*) You have tendered to Bostock for sulphuric acid?—Yes, but only since their name appeared in the paper.

4843. You never tendered to them before?—No. I tendered, I think, in November last, before much inquiry was made into the matter.

4844. (*Mr. Cosmo Bonsor.*) Might I ask you how your trade is worked; is it worked by travellers or circulars?—By travellers.

4845. I presume the travellers know pretty well each chemist's customers and do not call very much upon the other men's customers?—Yes.

4846. It is more or less of a ring, I presume?—That is so. I may add that my travellers have always made a point of warning these people against the use of pyrites acid on account of the danger of arsenic.

4847. Did your travellers go to Bostock's and tell them that?—No.

Professor Sheridan Delépine, Professor of Pathology, Owens College, Manchester, called; and Examined.

Prof. S. Delépine.

4848. (*Chairman.*) You are Professor of Pathology and Director of the Pathological Laboratories at the Owens College, Manchester?—I am.

4849. You are, I believe, frequently consulted by sanitary authorities in Lancashire, and you have been doing, with the assistance of Dr. Coutts and others, a considerable amount of research work upon arsenic in beer, at the request of the Town Council of Salford?—Yes.

Peripheral neuritis and higher alcohols.

4850. We have heard from Dr. Tattersall that on the 16th of November he consulted you in connection with the outbreak of peripheral neuritis in Salford, informing you that beer had fallen under suspicion. In the first instance, I understand, as you were told that samples of the suspected beer had been analysed and found to contain no poisonous substance, you turned your attention to the possible presence of certain higher alcohols. Can you tell us, in order to dispose of this part of the question, what ground you have for thinking that peripheral neuritis might be caused by higher alcohols?—Yes; but, as a matter of fact, I still maintained my belief that metallic poison was the cause of the outbreak; but, taking in account the results of the analyses which had been given as a indication that this theory might prove to be correct, considered the higher alcohol theory. This theory appeared improbable, for only a very small amount of these alcohols could be generated during the ordinary fermentation of wort, and there was not the slightest reason to believe that a number of brewers had adulterated their beer with raw spirits, which would, of course, introduce the higher alcohols, there was, however, a remote possibility of some new method of fermentation having been adopted, or of some unsuspected change in the yeast, that might give rise to a greater proportion of higher alcohols than normal. Raymann and Kruis have shown that certain yeasts grown under abnormal conditions may form amylic acohol, acetaldehyde, and furfurol (Joergensen, Les Micro-organisms de la Fermentation. Transl. by P. Freund. Paris, 1899, p. 182). Some researches conducted under my direction in 1894-95 by Dr. W. J. Kerr had indicated that the administration of various alcohols was usually followed, in rats, by symptoms resembling those of beginning alcoholic paralysis. Such effects were produced by doses smaller in the case of amylic alcohol than in that of the lower alcohols. On the supposition that these alcohols have the same effect on man as they have on rats, one may calculate, on the basis of the doses given to rats of known weight, the quantities which a man weighing 140lbs. would require to be influenced in the same way. The results of such calculations may be tabulated as follows:—

Prof. S. Delép.

I.—Administration by the Rectum.

	Experiment.	Duration of Experiment.	No. of Doses.	Average Dose.*	Daily Average.*
Methylic Alcohol	XII.	45 days	35	16 oz.	12·5 oz.
	XIII.	60 „	47	17 „	13·7 „
	XIV.	75 „	60	18 „	13 „
Ethylic Alcohol	III.	70 „	55	13·6 „	10·6 „
	IV.	70 „	55	11 „	8·5 „
	V.	60 „	48	17 „	13·9 „
Amylic Alcohol	XVI.	20 „	15	3·7 „	2·8 „
	XVII.	32 „	24	5·5 „	3 „
	XVIII.	23 „	18	5·5 „	3 „

II.—Administration by the Mouth.

	Experiment.	Duration of Experiment.	No. of Doses.	Average Dose.	Daily Average.
Methylic Alcohol	XXIV.	30 days	20	18 oz.	12·2 oz.
Ethylic Alcohol	XXIII.	52 „	42	16·6 „	13 „
Amylic Alcohol	XXV.	60 „	47	7 „	5·4 „

4851. What does the average dose mean?—The amount which was given at one time, and the daily average is an equalisation of all these doses, admitting that they were taken, equal daily doses.

4852. Calculated from the proportion, as the weight of the rat is to 140lbs., so is the dose you gave?—Yes, the table gives the amount which a man would have to take to absorb the same amount of alcohol that a rat was taking. The peculiarity of the paralytic symptoms

* The doses represent the amount of absolute alcohol given in each case. The methylic and ethylic alcohols were diluted with four times their weight of water. The amylic with three times its weight of olive oil.

produced in all these cases was that they followed rapidly after the administration of large doses of alcohol and gradually disappeared afterwards. The outbreak investigation showed symptoms very different from those which I observed in those rats.

4853. Would the corresponding amounts of alcohol necessary to produce similar poisoning in man be very large indeed?—Yes, the experimental doses were very large, and the alcoholic strength of the solution was much higher than that of beer. The rats were never kept alive for more than three months, and it is possible that smaller doses frequently repeated and given for a greater length of time might have given rise to more lasting paralysis. The symptoms indicated central rather than peripheral changes. That is to say, the hind limbs were paralysed first, then gradually the fore limbs; then the hind limbs would recover, and afterwards the fore limbs. There was a perfect equality of the symptoms on both sides of the body. The amount of alcohol necessary to produce the symptoms was greater in the case of methyl alcohol than in the case of ethyl alcohol; amylic alcohol acted in much smaller doses than either of the above. All these quantities were distinctly larger (and in the case of amylic alcohol very much larger) than the amount that might be expected to be present in a gallon of light beer. I am not speaking now of strong beer containing 10 per cent. of alcohol or more.

4854. It seems unlikely that there would be found in any community a sufficiently large number of persons capable of drinking an amount of beer large enough to account for the widespread outbreak of disease, and that the beer also should contain such a large quantity of a form of alcohol which is quite foreign to ordinary beer?—Yes, and as a matter of fact, we know now that many moderate drinkers did not escape. The alcoholic theory, though not unreasonable, was therefore insufficient.

4855. (*Dr. Whitelegge.*) What you observed was a central rather than a peripheral change, I understand?—Yes.

4856. So that it would be hardly peripheral neuritis?—It is very difficult to recognise in the early stages the share taken by nerve centres.

4857. But you regard it, do you not, as really central and not peripheral?—Yes. It may be that arsenical paralysis is also partly central. The nerves as well as the central nervous system are affected in the later stages, but it is difficult to say exactly how much the one precedes the other. But the symptoms were certainly very different.

4858. (*Chairman.*) You conclude that the alcoholic theory, though not unreasonable, was insufficient?—Quite.

4859. I understand that you were also considering the possibility of other causes of the illness, such as toxin produced by bad yeast, when you learned of the discovery of arsenic by Dr. Reynolds?—Yes. I was making preparations for an investigation of all the causes which appeared possible, metallic poisons being the most likely in my mind; but I took steps to investigate any other possible causes in case the more likely cause failed. But within four days of my consultation with Dr. Tattersall I heard that Dr. Reynolds had found that the incriminated beer contained arsenic. The importance of the discovery of arsenic by Dr. Reynolds was evident, and I at once offered Professor Dixon Mann, who had given me the information, one of my samples to verify the fact; this he did on the 21st of November, when he entirely confirmed Dr. Reynolds' discovery. We had no difficulty in proving the presence of a large quantity of arsenic in the beer (*see* Table I., Samples A, B, and C, Appendix No. 12), and a more complete knowledge of the skin symptoms to which attention had not previously been directed, made it clear that a cause, if not the sole cause, of the outbreak had been found.

4860. This table you referred to is contained in the pamphlet which I hold in my hand?—Yes. It is the same as Table I. to the special report to the Salford Town Council: "On an Epidemic of Arsenical Poisoning from Beer, 1900," by Dr. Tattersall, and a "Report of Chemical Investigation" by myself.

4861. May we take these tables as not requiring correction according to your present knowledge?—I have not noticed yet any error

4862. We will take these tables, then, as given in evidence?—There are three main columns. The first column gives the parts in ten millions so as to make all the analyses comparable for practical purposes; the number of grains per gallon is given in the second column. One and a-half grains per gallon was the maximum found.

4863. What does the word "private" mean?—That this sample of beer had been sent to me by another medical officer of health and was not one of Dr. Tattersall's samples. It was from Hyde in Cheshire.

4864. Is it known from what brewery it came?—It is known, but I am not at liberty to mention it because I got it privately. I know that Bostock's sugar was used there.

No arsenic found in Munich and Vienna beers.

4865. I see you mention Munich and Vienna beers with no traces of arsenic?—I could not find any trace of arsenic in either of those beers. The first thing I did at the beginning of the inquiry was to try and find any beer free from arsenic, and I obtained beers from various parts of the country and from the Continent. The only two beers in which I found at that time no trace at all of arsenic were one sample of dark Munich beer, which I have used since as a standard and for the dilution of other substances, and a light lager or Vienna beer.

A few English beers.

4866. Did you find in any other beer you tested beer absolutely free from arsenic?—A few beers obtained afterwards were occasionally free.

4867. What about the one marked N.?—N. contained apparently no arsenic, but I was not certain it was entirely free. When tested by Reinsch's method it did not leave the copper as clean as the Munich beer, but there was not enough arsenic there, if any, to allow of a sublimate being obtained.

4868. Would you say there was less than 1-100th of a grain per gallon?—I should say less than 1-500th. I would not like to give any number. I give this only as a kind of rough inference from the appearance of the copper.

4869. (*Dr. Whitelegge.*) Is it not the fact that other causes besides arsenic might affect the copper?—Yes; that is what makes it absolutely impossible to say whether there was or was not arsenic present in very minute traces. If there had been no possibility of any other substance giving a dark colour to the copper one would have said there was certainly a trace of arsenic.

4870. The only suggestion of arsenic is due to the discolouration of the copper, which might have been due to another cause?—Yes.

4871. (*Chairman.*) In the beer marked K, you found no arsenic?—I found only a trace.

4872. Was that discolouration of the copper or actual crystals?—When I put down a trace, there was actually a sublimate obtained, but so slight that it was a difficult thing to estimate the quantity.

4873. (*Mr. Cosmo Bonsor.*) Why did you go to Munich and Vienna?—The only reason I went to Munich was that there was an importer in Manchester from whom I could get genuine German beers easily. I tried to get beer direct from the Continent, but I found it was difficult. I went to Munich because I knew there was a strict law there prohibiting entirely the use of malt substitutes. I thought that by going to a country where the law was very strictly enforced I might probably get an idea of what beer produced under those conditions would be like.

4874. (*Chairman.*) When you commenced the inquiry, did you find arsenic in large quantities in your beer samples?—Yes; and we found that the poison was sufficiently abundant to make its detection easy in less than half a tumbler of certain beer. Nothing but an artificial product used in large quantity could account for such a contamination. Of the artificial products used for brewing purposes, brewing sugars are the only ones which are used in large quantities. I therefore concluded at once that the brewing sugars had most probably been the means of introducing arsenic into the beer. Glucose had been previously shown to contain at times a large amount of arsenic, derived from impure sulphuric acid.

4875. Had that been found before the outbreak of the epidemic?—I knew it had been found previously

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by some observer, and I have found since then the exact reference to his work.

4876. Can you tell us first about the sulphuric acid?—The sulphuric acid I found not only to contain a large amount of arsenic but also to be actually supersaturated with the poison. Part of the arsenious acid had separated from the acid in the shape of a white precipitate. The nature of that precipitate was at first a matter of doubt. It was neither sulphate of lead, nor sulphate of iron or lime. I ultimately discovered that it was composed of arsenious acid or of some substance composed almost entirely of arsenious acid. I was able to obtain a precipitate having the same properties by supersaturating pure sulphuric acid with pure arsenious acid. The precipitate was also found by actual analysis to contain more than twice as much arsenic as the fluid above it. This fact was communicated to the members of the Brewers' Committee, when they visited my laboratory on the 8th of December. Since then Professor Campbell Brown has confirmed the view stated above and made a most interesting research on the subject. With his permission I will read part of a letter which I received from him on the 9th of February, "I have got the most beautiful proof that the needles in the B.O.V. deposit are pure As_4O_6, essentially. I have seen these rhombic prismatic needles (afterwards proved to be practically free from Calcium and Iron, or only containing traces), break up into strings of octahedra flattened at two sides. These in the solution containing some arsenic, grew into larger perfect octahedra. The needles broke up (like the yellow HgI_2 does) into the smaller red crystals . . . . . I find that the formation of the labile rhombic prism form has already been observed from a potash solution supersaturated with arsenious acid." I had therefore found that sulphuric acid contained an amount of arsenious acid much more than sufficient to account for all the arsenic present in the sugars, and that certain brewing sugars contained enough arsenic to explain the large quantity of that substance present in the beer.

Arsenic in Nicholson acid.

Arsenic in Bostock glucose.

4877-9. I believe you asked Dr. Coutts to test glucoses for arsenic?—Yes. Dr. Coutts is one of my assistants engaged in this work, and immediately I received samples of glucose from the brewers I asked him at once to test for arsenic, and on the same evening (November 22nd) he found a large amount of arsenic.

4880. Did he test in your own laboratories?—Yes. He found a large amount of arsenic in one of the three samples which had reached us the same day. There was a very marked difference between that sample of glucose and the other samples of glucose we received at the same time.

4881. Is No. 23 of Table 4 (Appendix 12) the specimen?—Yes, the actual specimen. That is a table giving the amount of arsenic found in various brewing sugars, including that one.

4882. No. 23, yellow, 6,000 parts by weight in ten millions?—Making 4 1-5th grains of arsenic per lb. of glucose.

4883. The greatest number I see in this table is 9,500 parts in ten millions, that is to say, 9½ parts by weight in 10,000, in one of the Bostock sugars?—Yes.

4884. Had that sugar been suspected or tested before to your knowledge?—Not that I know of. That glucose we got amongst the second lot of samples which had been collected by Dr. Tattersall. Immediately Dr. Tattersall heard of my finding arsenic in sample 23, he enquired as to the source of that glucose, and the day after I had reported to him went to Liverpool, to the factory from which that glucose had been bought, and collected the other samples of glucose, dark brown, pale yellow, yellowish white, and the various samples of glucose he could obtain from Bostock's factory.

4885. Was that 9½ parts in 10,000 found by a rigorous quantitative analysis?—Yes.

4886. And not merely by estimating the appearances of the sublimates?—Yes, by comparison with standard sublimates; I consider this is a very rigorous analysis because it allows one to find differences of less than 1,000th part of a grain.

4887. That was practically one part in 1,000?—Yes; and this is not over-estimated.

4888. Is that the largest quantity?—Yes: it is the largest quantity we have found in any of the brewing sugars, the next one being 6,000 in ten millions.

4889. Which was also Bostock's?—Yes.

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4890. I see in Table 4 a sample from brewery A, with an asterisk, marked 6,000 parts per ten million—No. 23?—That is the first sample which gave us the clue to the origin of the arsenic in the beer.

4891. Do you know for certain the origin in that sugar?—Yes; it came from Bostock's. All the samples which are marked with an asterisk have been found to have come from Bostock or have been obtained from Bostock's themselves.

4892. I see four specimens of sugars from different breweries, two of which contained apparently not a trace, and the other two contained ten and seven respectively in ten millions. Were those Bostock's?—They were Bostock's.

4893. The four almost quite free from arsenic were not Bostock's?—They were not.

4894. Do you know where they came from?—I did know, but I cannot remember now. I should think it was from Garton, Hill, and Co.

4895. Can you tell us more definitely where they came from by referring to your notes?—Yes; and I will let Dr. Buchanan know. I think, however, that it would be better for Dr. Tattersall to give the origin of those samples, as I have really no right to give the origin of any that I received from him. I was doing this work for his authority.

In Bosto invert su

4896. Then I see invert sugars here made from cane sugars by the action of sulphuric acid?—Yes.

4897. You have as much as 2,000 in two of these, both of them from Bostock's?—Yes.

4898. Is some of that sugar crystalisable?—Some of the samples were crystalised. I have not tested whether the others were crystalisable. Some of them were in solution.

4899. I see one of them containing 2,000 was crystalised; was it dry crystals?—It was like honey which has set, crystalised honey which has been kept for some time, opaque, semi-solid.

4900. One of these invert sugars contained practically no arsenic—seven parts in ten millions. Was that from Bostock's?—No. There are two invert sugars not from Bostek's which contained scarcely more than a trace of arsenic.

Arsenic i glucose before th epidemic

4900*. Do you mean to say that before suspicion was raised by the recent outbreak it had been found that some glucose employed for beer contained arsenic?—Yes. In some cases a large amount.

Observat of Clouet Ritter.

4901. Before the recent outbreak and before the present inquiry, you had evidence of arsenic in glucose?—Yes; Monsieur J. Clouet, in the Annales d'Hygiene Publique, 1878, p. 145, mentions that, in searching for the source of the arsenic sometimes present in wine, he found that fuchsin is often incriminated wrongly, but that the caramel which is frequently used in conjunction with fuchsin often contains a large amount of the poison.

4902. Caramel is used as an article of food, is it not?—Yes; and for colouring many drinks, cider, wine, etc.

4903. Is caramel pudding made of caramel?—Yes.

4904. Is that the caramel mentioned here?—No, this is commercial caramel. This caramel is made from common glucose and used for colouring, while the caramel used in cakes is usually made from cane sugar, I suppose.

4905. The arsenic which Clouet found in caramel may probably have come in by the sulphuric acid?—Yes. This was certainly due to the use of impure sulphuric acid by the manufacturers of glucose, and he mentions certain glucose factories where such impure sulphuric acid made from Westphalian ores had been used, and where highly arsenical glucose was manufactured. Ritter and Clouet found that the arsenic is derived from impure sulphuric acid which was then not infrequently used in the preparation of glucose from which caramel is made. Arsenic is always more or less abundant in sulphuric acid prepared from arsenical pyrites. In addition to arsenic, glucose frequently contained a large proportion of free sulphuric acid, this being the effect of imperfect neutralisation of the acid after conversion of starchy matters. I have summed up the results of Clouet and Ritter's analyses in Table 12. (Appendix 12.)

4906. I see from this table that the highest amount

of arsenious acid in glucose reported by Clouet was nine parts per million, or 0·063 grains per lb., and by Ritter, in dark German glucose, 143 parts per million, or 1 grain per lb.?—That is so. Clouet gives among the substances which may be contaminated with arsenic through arsenical glucose:—Wine, by the use of caramel prepared from arsenical glucose; cyder, by the use of caramel prepared from arsenical glucose; syrups, by the substitution of glucose for cane sugar; jams, by the substitution of glucose for cane sugar; sweets, by the substitution of glucose for cane sugar; gingerbread, by the substitution of glucose for honey or treacle; tobacco, which is sometimes moistened with solutions of glucose to prevent overdrying and brittleness, etc. Invert sugar is obviously another substance of this sort. It is much sweeter than glucose, and resembles honey much more closely.

4907. We have it on record that glucose was known as early as 1878 to be contaminated by arsenic?—Yes;

4908. Through the use of sulphuric acid?—Yes.

4909. Have you information even before that time?—Yes. I have not been able to get access to Ritter's work, but it is given very fully in Clouet.

4910. Is there any English reference to this?—Yes. Dr. Wynter Blyth has given reference to Clouet's work in his book on foods and poisons.

4911. Is that a book in common use, known to students and experts?—It is known to public analysts, I think. I may say that the reference is given in a footnote which might not attract attention, and there is no proper reference to it in the index, so that it might be easily passed over. A reference is also given to the presence of arsenic in glucose in Thorpe's Dictionary of Applied Chemistry, 1898, art. Arsenic p. 201.

4912. Arsenic is always more or less abundant in sulphuric acid obtained from certain sources?—Arsenic is always present in sulphuric acid made from arsenical pyrites.

4913. The effect of imperfect neutralisation of the acid would tend to leave more arsenic in the glucose than if perfect neutralisation had been practised?—Yes. After being manufactured the acid which has been used for manufacturing the glucose is neutralised, with carbonate of calcium usually, and if the neutralisation is not complete a pretty large amount of sulphuric acid, containing the maximum amount of arsenic, is left in the glucose.

4914. If the neutralisation by lime was complete arsenic would still be left?—Yes, a large amount of arsenic would be left.

4915. But not so much as when the neutralisation is not complete?—I could not give a very positive opinion on that, because I have not examined the sulphate of calcium produced during the process of neutralisation and compared the amount of arsenic taken by the sulphate of lime and the amount of arsenic taken by the sugar. Arsenic is very soluble in solutions of sugar, and possibly more arsenic remains in the glucose than in the sulphate of lime. Therefore it is difficult to apportion what there would be in the sulphuric acid retained in the glucose.

4916. If the neutralisation is not complete there would be a strong acid reaction?—Yes.

4917. Would it be perceptible to the taste?—We had a sample of glucose which had a strong taste of sulphurous acid, but we have not had one which showed any permanent acidity such as is produced by sulphuric acid among the samples we have tested. The glucoses which we have obtained in England were very nearly all neutral.

4918. Practically the neutralisation is generally complete in the manufacture of glucose?—So far as we could ascertain it was complete, whilst in Clouet's time it seems that neutralisation was not carried out well because he found in some cases a very large amount of sulphuric acid. This is given in the table which has been already referred to.

4919. I see in Table 12 sulphuric acid made from pyrites at Westphalia over one half of a gramme of arsenious acid per kilogram?—That is the minimum.

4920. The largest amount of arsenious acid in glucose in this table is ·009 of a gramme per kilogram, by Clouet?—Yes.

4921. By Ritter, on the other hand, in dark glucose of German manufacture as much as 1-10th of a gramme per kilogram was found?—Yes.

4922. And that is the largest amount of arsenious acid in glucose found by even Clouet or Ritter, as shown in your table?—Yes, it makes one grain per lb.

4923. What is the highest in the Bostock glucose?—Six times as much. 6 3-5ths is the highest in Bostock's.

4924. You mentioned the substances that Clouet found contaminated with arsenic. Does he give evidence of arsenic being actually found in them?—I do not think he gives evidence of this, but it seems to be rather by inference.

4925. As a warning?—Yes. He insisted upon the importance of the application of a certain Act which corresponds somewhat to the Sale of Food and Drugs Act, and insisted also on the importance of using that Act very strictly for the purpose of preventing the presence of arsenic in articles of food.

4926. Did he propose legislation?—He said the legislation was sufficient, and should be strictly enforced. He seemed to indicate by his statement that there was legislation, but it required to be strictly carried out.

4927. (*Dr. Whitelegge.*) Can you say whether the legislation was directed against adulteration or against the presence of arsenic?—It was directed against the presence of poisonous substances. I do not go into questions of administration generally, and I might easily make a mistake, but I can bring the book if it is necessary.

Tests for arsenic in beer.

4928. You have kindly shown to the Commission already illustrations of the method of analysis which you follow. Will you now tell us the methods of analysis you adopted?—Many methods are available for the detection of arsenic, but there is considerable difference of opinion among authorities regarding their relative merits. Marsh's and Reinsch's test are generally considered reliable for the detection of small quantities of the substance. The latter is specially useful in the case of organic substances, and though requiring care to avoid errors, is comparatively simple. Marsh's method necessitates in certain cases the breaking up of organic products, and a number of operations, several of which may introduce sources of error or loss of arsenic. Except for the fact that no record of the application of Reinsch's test to the analysis of beer and of brewing material could be found, this method was clearly indicated. There was, however, so great a difference of opinion among experts as to its delicacy and reliability that I found it necessary to make a number of carefully controlled preliminary experiments before adopting it finally. Scherer gives the delicacy of Reinsch's test as being 1-250,000 (Watt's Dict., 1888, I., p. 304, Thorpe's Dict., 1898, p. 194). Taylor says that by this method the 1-150th to 1-200th part of a grain of arsenic may be detected when held in a small quantity of fluid (Medical Jurisprudence, 1873, p. 262). Fleitmann's test is less delicate than Reinsch's test (Thorpe, l.c.). I have satisfied myself by testing solutions of definite quantities of arsenious acid in beer free from any recognisable trace of arsenic, that it was easy to detect 1-100th part of a milligramme, *i.e.*, 1-6,500 grain of arsenious acid in 100 cc. of beer, without concentrating that fluid, so that by Reinsch's method one part of the poison can be rapidly detected in 10,000,000 parts of beer. This degree of delicacy is, I believe, greater than had been suspected before, and distinctly in excess of what was needed for my purpose. Marsh's method did not give us results equally satisfactory, and would have led us in many instances to considerably underestimate the amount of arsenic, judging by the results of a number of comparative experiments. With regard to various brewing materials, the Reinsch's process proved equally satisfactory. An objection which has been offered to the Reinsch's process is that it is applicable only to arsenious acid and arsenites. It has, therefore, been supposed that if arsenates were present in beer, some arsenic would escape detection by the method. It seemed to me improbable that arsenic acid should be produced at any stage of the preparation of sugars or during the brewing of beer, reduction of metallic salts being far more likely to occur than oxidation during these processes. It was also probable that in the event of arsenates being present in beer, the boiling of these salts for an hour in presence of a large excess of organic matter and of hydrochloric acid would bring about some decomposition. This was proved to be the case by testing samples of arsenic free beer, to which arsenate of sodium and arsenate of potassium (in the proportion of one part of salt to 100,000 parts of the fluid) had been added; after three-quarters of an hour boiling a considerable amount of arsenic was found to have been deposited on the copper; a further amount of arsenic was subsequently separated on allowing of a

Quantitative use of Reinsch test.

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more lengthened action. The amount of arsenic thus recovered was about one-fourth or one-third of what would have been obtained had an amount of arsenious acid equal to that of arsenate been added to the beer. The amount of arsenic contained in one part of arsenate of soda is about one-third of what would be contained in an equal weight of arsenious acid, so that only a small proportion of the arsenates, if any were present in beer, would escape detection by the Reinsch's test. The new method of quantitative analysis which I was led to adopt was based upon the following observations. 1st. When five parts of a watery solution containing arsenic are mixed with one part of hydrochloric acid, and boiled for half to one hour, in presence of arsenic-free copper foil, the amount of arsenic precipitated on a surface of copper of definite size is proportional to the amount of arsenic in the solution. This is true within certain limits only, for when the amount of arsenic in the solution is very great, the copper is rapidly covered by a thick spongy layer of arsenic, which is very easily separated, and also possibly interferes with a complete deposition of arsenic from the fluid. To obtain good results it is necessary to use solutions containing less than 1-10th milligramme of arsenious acid dissolved in 100 or 200 cc.'s of fluid, *i.e.*, less than 1 part of arsenious acid in 1-1,000,000 parts of fluid. Such solutions give on a piece or pieces of copper foil offering an aggregate surface of 84 square millimetres (¼ × ½in.) precipitates which are suitable for comparison. The arsenic is deposited with remarkable uniformity over the whole of the exposed copper surface. Secondly: Arsenic is unfortunately not the only substance which is precipitated on the surface of the copper, else the different tints produced by deposits of various density might be utilised to estimate the amount of arsenic. To a certain extent this may be done, but no absolute reliance can be attached to such estimation. Various substances containing sulphur are usually present in beer and brewing material; a dark discolouration of the copper is often the result of their presence. Selenium, antimony, mercury, silver, bismuth, platinum, palladium, tin, gold, are also deposited on the copper under the same conditions. This shows the impossibility of estimating the amount of arsenic deposited by a weighing or by a simple colorimetric method. Thirdly. When the deposit of arsenic is volatilised in narrow sublimation tubes, or in small cells of suitable size, the metal is oxidised and deposited in the form of crystalline arsenious acid. The size and number of the crystals are, within certain limits, proportional to the dmount of arsenic. From one half of the quantity of copper indicated above, it is easy to obtain a characteristic sublimate from 100cc.'s a solution containing 1-100 milligramme of arsenious acid. Fourthly: Sublimates being obtained in this way from standard solutions prepared by adding 0·00001, 0·00005, and 0·0001 grammes (*i.e.*, 1-100, 1-20, and 1-10 milligrammes) to 100 cc.'s of arsenic-free beer, constitute a scale of three standard sublimates which may be used for purposes of comparison. Of these sublimates the most useful for comparison is the one corresponding to the smallest amount of arsenic, since it is composed of crystals of more uniform size than the others. It is, however, possible to recognise whether a sublimate is about equal to, or more or less abundant than, one of the three standard sublimates composing the scale. The difference between the three degrees are very marked, even to the naked eye, as is shown by the photographs of the sublimates of arsenious acid obtained respectively from solution containing 1-100, 1-20, and 1-10 of a milligramme in 100cc.'s of beer. To obtain quite comparable results it is obviously necessary to use tubes of uniform calibre in all analyses. It is equally important to use reduction tubes of the same size when the Marsh apparatus is used for the purpose of the testing. Whatever method is used the exact size of the tubes in which the reduction or sublimation of the metal is produced should be of a uniform calibre, determined by a central authority and stated in the description of the analysis. Fifthly: When a solution contains an amount of arsenious acid larger than those corresponding to any of the standards, to reduce the amount of arsenic precipitated on the copper it is necessary to reduce the amount of fluid. I have found by experiments that 50cc.'s of beer, containing 0·00005 grammes of arsenious acid give a sublimate proportionate to that given by 100cc.'s of beer containing 0·0001 grammes of arsenious acid. When the fluid contains so large a quantity of arsenious acid that it would be necessary to reduce the quantity to less than 10 to 29 cc.'s, dilution must be resorted to in order to bring the quantity of arsenic within the limits required. Sixthly: The smallest quantity of arsenic (deposited on copper) which can be used to obtain a definite sublimate depends on the size of the sublimation tube. With a tube the bore of which is less than one-eighth of an inch (3mm.) in diameter, it is easy to get a sublimate with the deposit obtained from 1-100 milligramme of arsenious acid. Seventhly: To obtain absolutely comparable sublimates it is desirable to cause them to form upon a flat surface, against which the gaseous products rise at a right angle. To meet this requirement, I devised a special form of sublimation cone, which gave excellent results. I had at first determined the size of the cone for minimum quantities corresponding to 1-10 milligramme. Owing to the pressure of work, I could not find time to determine the size most suitable for 1-100 milligramme, which I finally adopted as the standard minimum limit. I have therefore been obliged to content myself with the results obtained with thin walled tubes (diameter 3 mm.). Owing to the unequal distribution of the sublimate in such tubes, great care must be taken in comparing them with the standards, but the differences between the three standards are so marked that no material error is likely to occur. It must also be remembered that the intervals between the standard degrees correspond to quantities not exceeding 1-1,300th part of a grain. The above details seemed to me necessary to justify my using a new method of analysis which had not yet stood the test of time. It will be noticed that Professor Dixon had found some difficulty in obtaining by the classical methods satisfactory results in a short time, and with a comparatively large amount of material. The use of such methods would have lengthened our investigations beyond reasonable limits. I found it possible by the new process to obtain sufficiently accurate results with quantities of material not exceeding three or four ounces in any case, and with a small fraction of such quantities in most cases. These results could generally be obtained within two or three hours—a most important matter; they were also easy to control. The same method was applicable to all products under investigation. It must be noted that the aim is not to obtain a complete precipitation of all the arsenic present, but to get a precipitate proportional to the actual amounts.

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4920. What was the exact procedure which you adopted?—It was as follows: First. Preliminary Test: 100 cc.'s of beer, to which is added pure hydrochloric acid (1 part of acid to 5 parts of beer), are boiled in the presence of two pieces of copper, measuring exactly ½in. square each. If after boiling this gently for one hour, the copper remains absolutely bright and unaltered in colour, the beer is considered free from any material trace of arsenic. For the purpose of confirmation, 200 cc.'s of beer are submitted to the same test. For experimental purposes, 500 cc.'s and even 1,000 cc.'s of beer have been used in some cases without any arsenic being discovered (Tables I. Sample II.)*. When the copper is dulled and shows any alteration of colour, greyish red, purplish red, steel blue-black, or dull black with spongy appearance, and when the deposit gives a sublimate of arsenious acid, arsenic is certainly present in the beer. Second. To make a rough estimate of the amount of arsenic present: One piece, or a fraction of a piece of copper, according to the colour, is sublimated in a small sublimation tube with thin walls. If crystals of arsenious acid are obtained, the sublimate is compared with the 3 standard sublimates. If the sublimate corresponds to one of the standard sublimates, it is assumed that the quantity of beer corresponding to the quantity of copper used contains about the same amount of arsenic as 100 cc.'s of the standard solution indicated by the standard sublimate. Thus if ¼ of 1 copper gives a sublimate corresponding to the sublimate obtained from 1 copper used in testing a solution containing 1-100 milligramme, it is assumed that the beer tested probably contains 1-100 of a milligramme in 25 cc.'s. Third. Control and final estimation: In a case such as the one given above, 25 cc.'s of the suspected beer are tested as before (2 pieces of copper being used). If from one copper a sublimate equal to 1-100 a milligramme is obtained, the previous estimate is considered satisfactory. If the sublimate is more abundant and does not exceed the 1-10 of a milligramme standard, the amount of sublimate is approximately fixed by careful comparison. In the improbable event of the sublimate being more abundant than the 1-10 of a milligramme standard, a third test is made with a smaller quantity of beer.

* Appendix 12, p. .

4930. (*Sir William Church.*) With regard to what you say of the reduction tubes, you mean as an estimation of quantity?—Yes. *Prof. S. Dexpine.* 29 Mar. 1901.

4931. It would be immaterial for the estimation of its presence?—By no means. By using tubes of sufficiently large size such as I have seen used by several people who have made analyses, it would be very easy to overlook a very material amount of arsenic.

4932. From the arseniuretted hydrogen passing through without leaving any deposit at all?—My remark did not apply to the Marsh test, although it would be probably quite as easy to make a mistake with Marsh's test as with Reinsch's test. With the Reinsch's test, although one may get a good precipitation of arsenic on the copper, if this arsenic is sublimated in a tube a little over a quarter of an inch in diameter it becomes practically impossible to obtain a clear sublimate unless the amount of arsenic be very large indeed. A great part of it escapes from the tube. There are convection currents which carry up the vapours or small crystals before they are deposited.

Mr. Henry Weld Blundell, called; and Examined.

4933. (*Chairman.*) You are chairman of the Cornbrook Brewery Company, Limited?—Yes. *Mr. H. W. Blundell.*

4934. Your brewery were customers of Bostock's?—Yes.

4935. And were more or less concerned in the late epidemic?—Yes.

4936. Is glucose used in your brewery?—No; not at all. It never has been.

4937. Is invert sugar used either for brewing, priming, or for both?—It is used for brewing, but not for priming, except in the case of stout, when we use a very little, but in all other brews we never use any priming whatever, and never have done, but only use invert sugar, putting it in the copper, and therefore it goes through the whole process of brewing, and not, as is usually done, added at some other period.

4938. It goes through the process of fermentation?—Yes; as well as being boiled in the copper.

4939. Prior to the fermentation?—Yes; the very first process. It is put in the copper with all the wort, and therefore it is boiled, and then passes through the filtering process through the hop back, and then over the refrigerators, and so forth, passing on to the fermentation. Therefore we attribute to that the fact that we have had very much less arsenious acid than theoretically we ought to have had. We attribute it to the fact that it has been precipitated. The boiling process, the filtering process, the fermentation, and perhaps the deposit on the coolers and refrigerators has resulted in a certain amount being carried off.

4940. The fermentation carries off some of the arsenious acid that was in the invert sugar?—Yes, I think so.

4941. In what proportions were you using invert sugar in different kinds of beer between June and the end of November last?—Between about 8 per cent. and about 12 per cent.

4942. Eight per cent. of invert sugar and 92 per cent. of malt?—No; of total materials used.

4943. Including the water?—No; the materials put in for use in brewing.

4944. That is to say, 8 per cent. of the total materials, the total materials being——?—Malt and other ingredients. We use a certain amount of raw grain.

4945. (*Mr. Cosmo Bonsor.*) Flake malts?—No; maize grits.

4946. (*Chairman.*) Those other materials would be called malt substitutes?—Yes; malt and malt substitutes.

4947. How much malt would be in that percentage?—It would be rather difficult to say, it varies so much in all kinds of brews. I have calculated that only from the point of view of the proportion of sugar to the total materials used. If you like, I would mention the quantity of invert sugar containing the arsenic to each barrel, it represents about 4lb. 7oz. in single X beers. In the case of other qualities it was rather more, 5lb. 6½oz.

4948. (*Mr. Cosmo Bonsor.*) What would be the gravity of that single X beer, 19?—Less than that; about 16. A quarter of malt would produce about 4 barrels and a-half.

4949. (*Chairman.*) The alcohol reduces the gravity, but the other substances increase it?—Not necessarily. I refer to the gravity of the worts before fermentation. It is the sugar matter which the yeast has to act on afterwards.

4950. Is that 4lbs. of invert sugar per barrel of 36 gallons the maximum or minimum average?—In some beers, for instance, in what we call best mild beers, there is as much as 5lbs. 6½oz. of sugar to the barrel, or rather more.*

4951. How much of the invert sugar used at this period came from Bostock's?—At this particular period we were using nothing but Bostock's. We have had for some years past contracts with the two producers of invert sugar, Garton Hill's and Bostock's, and we pay the same price for the material to both manufacturers. In both instances we got the best, and we had about equal quantities from each. Sometimes we were getting deliveries on one contract and sometimes on the other. It so happened that between about May or June last and November we were running on Bostock's contract. The contract with Garton Hill had dropped for the time being. Invert sugar obtained from Bostock's

4952. (*Sir William Church.*) As early as May?—I think I am wrong, I find it was July.

4953. It is a very important thing to know when you changed?—It was only by accident we went from one to the other; it was about July.

4954. At present we have not any mischief arising so early as May?—This is quite irrespective of any mischief. In July we started on Bostock's contract and suspended the other.

4955. (*Chairman.*) Had you any reason for going from the one to the other contract?—None whatever. It was a pure accident.

4956. It was not a question of rival estimates?—No; they were precisely the same. The price we paid for both Bostock and Garton Hill's has been the same for some years.

4957. Had you any expert knowledge in your place of the qualities? Was the one supposed to be as good as the other?—Yes; we had them periodically analysed, and we judged best by the results of the mash tun, by the specific gravity of beers produced from the use of these materials. But, of course, we never suspected that arsenic would be there, and therefore never had it analysed for arsenic. Never analysed for arsenic before 1900.

4958. Your analysis consisted in determining the brewing value of the ingredients?—Yes; and what quantities of dextrose and levulose, and their freedom from any other deleterious matter.

4959. Your analysis was partial?—It was purely for our own purposes in the brewery.

4960-1. How long had your firm been Bostock's customers, more or less?—For a great number of years—about ten years.

4962. Was there any invert sugar used for brewing 10 years ago?—I could not say, but we did not use it more than 10 years ago.

4963. So that from the beginning of your use of invert sugars you took it sometimes from one and sometimes from the other?—Sometimes from Bostock and sometimes from Garton Hill.

4964. Never from any other maker?—No.

4965. After the discovery of arsenic what steps were taken by your brewery?—At our first meeting of the Brewers' Association which has been referred to by other witnesses, we were informed for the first time that something was wrong with some of the beers. We had heard before that there were some beers brewed by some breweries which were causing a certain amount of sickness, but we presumed it was only from some defect in the brewing. We discovered on this date—which I think was the 23rd November—that there was something more than that, something seriously wrong. The next morning, the 24th, a Action by brewery on discovery of arsenic.

* Note.—Further details since submitted by Mr. Blundell appear in Appendix, No. 15.

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Saturday, I went off myself to Owens College to see a very able chemist there, Mr. Kirkby, an analyst, to ask him to analyse our beers for arsenic, which we heard for the first time that morning in the newspapers was known to be present in some samples of beer. At that time we had not the smallest suspicion we had any, and we simply went there to satisfy ourselves of its freedom from arsenic. Dr. Kirkby analysed it, and in the course of a couple of hours asked us to meet him, and he told us that there was arsenic present. He immediately asked me whether I used Bostock's sugar, and I told him we did, and he said, "That is the substance which contains it." He showed me a sample by some process I cannot remember now—it was neither the Reinsch test nor Marsh's test—but by precipitation on blotting paper. He showed me the stains produced by the deposit of arsenious acid in the beers of other brewers which he did not name, and compared ours with it, and the conclusion I came to was that we undoubtedly had the arsenic present, but in very small proportions, because the stain was almost colourless, whereas the others were distinctly brown stains. That was the first intimation that we had of any arsenic. I then went back immediately to the brewery, and stopped brewing any more with Bostock sugar, and from that time we produced beers without any sugars at all for a week or ten days, and then we went on with our contracts with Garton Hill. I was still, of course, under the impression from what I had seen and heard that by using no glucose and a small quantity of invert sugar there was no harm in our beers at all, but two or three days after that it appeared in the papers there was danger resulting from the use of any, and it was supposed then that deaths had resulted from it, and we stopped sending out any beers at all containing Bostock's invert sugar. That was three days afterwards, Wednesday, 23rd November. We then sent a circular out to all our tenants and to all our customers with some labels, instructing them to fasten on our barrels a label stating "Not to be consumed," and then as soon as possible we sent round our own travellers and carters and clerks to pour all the beer down the drains, that contained any of Bostock's sugar.

4966. Were you able to do that to other than your own tenants?—We followed the beers to publicans and free customers, and submitted as soon as we could beer without Bostock's sugar for what they had poured away, but we found very little difficulty. People behaved exceedingly well. The only difficulty we had was that some of the tenants refused at the beginning to send their beer down, because they said they had never heard of anybody who had suffered injury from it, and did not believe there was anything wrong with it. We insisted upon it, and the beers were all poured down.

4967. Did you have any of those beers analysed for yourselves?—Yes; I had a good many at the beginning. I thought, of course, it might have been only one particular sample of Bostock sugar. We all did, in fact; we thought it might have been an accidental consignment, and as we got small consignments over at a time I concluded it was only perhaps one or two brews. But we had a number of beers analysed, and they showed an extraordinary difference in the percentage of arsenic present; some of them showed the faintest trace only. In fact, the analysis given to us would show that it was practically free in many instances down to ·01 of a grain of arsenic to a gallon of beer, which was practically negligible; others, had more. In order to verify the quantitative analysis I took the sample which contained the most of any, ·2 or 1-5th of a grain per gallon, and sent it to a London firm, one of the best firms we could find, to verify the analysis, and they reported—I do not mention their names, for obvious reasons—but they reported they had analysed it several times, and they gave us a certificate that there was no trace whatever of arsenic in the beer. I do not mean to allege that the sample contained no arsenic. I take it for granted it must have been there, but I only mention that to show the difficulties that existed in discovering it.

Divergent results of different analysts.

4968. That beer was the beer you had tested in Manchester?—Yes.

4969. It showed traces in Manchester?—Yes; and we sent it to a well-known London firm, and that was their certificate in return—perfectly pure.

4970. The beer that contained 1-5th of a grain per gallon was sent to London?—Yes.

4971. (*Dr. Whitelegge.*) 1-5th of a grain was not regarded as a trace?—No. That was a case of the worst we had. I sent that to London to obtain a quantitative analysis of arsenic, feeling that it might be a necessity to take precautions. *Mr. H. Blund* 29 Mar.

4972. (*Chairman.*) That illustrates the great difficulty in getting a trustworthy test?—Yes.

4973. Has any action been taken by any sanitary authority against any retailer of your beer?—In Manchester and Salford and districts around there have been four summonses taken out against tenants of ours for containing very small amounts. They put it, "in excess of so much"—I cannot remember what the quantities were, but they were very small. It may have been only for the purpose of prosecution. All the cases have been deferred pending the decision given upon the Appeal upon a case that has been stated for the higher Court as to the particular clause which was concerned in the summons. Mr. Fletcher Moulton, who defended the first case, not ours, contended that the summonses were taken out upon the wrong clause. I think it was the third clause instead of the sixth, and a case was allowed to be sent to the higher Courts. All our cases, therefore, are dependent on that particular decision. Prosecu in respe arsenic beer

4974. (*Dr. Whitelegge.*) Were those cases taken against your company or against the tenants?—Against the tenants. The summons was taken out against the tenant alone. t ken against retailer

4975. But you defended?—We have not defended them, because they were not even brought into the Court. The tenants were told that their cases were deferred until the appeal was decided. I take it that if this decision in the first case by the Stipendiary of Manchester is upheld these prosecutions will be continued.

4976. (*Chairman.*) Were there any prosecutions outside Manchester?—One outside Manchester in an outdistrict.

4977. Did that go on?—Yes, it was a case at Radcliffe, where a small fine was imposed.* A barrel had been left of the old brew; the whole of the brew had been thrown down the drains, but this particular barrel was left there, not for consumption, and the tenant had never sold any of the beer to anybody at all, but the policeman came into the cellar and saw the barrel there, and asked why it was it had not the labels on with the others warning them not to be consumed, and he said: "Well, it is there, but I have not sold any of it." He was then drawing from other barrels free from arsenic, but having it in his possession I suppose he was prosecuted and fined a small fine, but none of it had passed into consumption at all. The barrel was full.

4978. (*Chairman.*) If the label had been put on there could not have been a prosecution?—I do not know whether there could be or not.

4979. (*Mr. Cosmo Bonsor.*) Under what Act of Parliament was this justified?—I do not think it is justified at all. I think it is perfectly illegal. It was not for sale, but the policeman exercised his power and the tenant did not like to refuse.

4980. (*Dr. Whitelegge.*) Why was it there?—It was sent out before the discovery of arsenic in beer; the reason for it not having been put down the drain was that we believed that that particular brew was free from arsenic. It had been tested and found free; that particular brew was believed to be safe, and therefore this brew remained for a few days longer than the others. Then it was found that all Bostock's beers were contaminated. But the moment we found that also must contain arsenic because it was brewed from Bostock's, it was ordered to go down the drains as well.

4981. (*Mr. Cosmo Bonsor.*) Was the prosecution in that case under the Sale of Food and Drugs Act?—Yes. The constable went down to the cellar and insisted upon the beer being drawn.

4982. Was he a constable or an inspector of the County Council?—I think he was an ordinary constable.

4983. An ordinary police constable?—Yes; sent out

* *Note by Witness.*—My manager informs me that the case in which the inspector took a sample from the barrel in the cellar occurred in Rochdale, not in Manchester, as stated.

for this express purpose under the Sale of Food and Drugs Act for the purpose of taking samples.

4984. (*Chairman.*) And a sample was taken?—Yes; he was not satisfied with taking what came through the taps and offered to the public, but insisted on going down into the cellar and chose this particular barrel from which he took this sample. Then he insisted upon the tenant taking the money for it so as to comply with the Act.

4985. The tenant might have refused to take the money?—He might have refused, but a tenant does not like to refuse an officer, as he calls them.

4986. (*Mr. Cosmo Bonsor.*) I am asking because I wanted the Commission to get the knowledge whether the prosecution was under the Sale of Food and Drugs Act? What I anticipate is that probably the constable was practically authorised by the local authority, acting under the Sale of Food and Drugs Act?—Yes, undoubtedly, I think he was.

4987. He did not go as an ordinary police constable?—No, he went practically as an inspector under the Sale of Food and Drugs Act.

4988. (*Chairman.*) Does your analytical chemist have a specimen of each brew?—Now he does. Since the 26th November a sample of every brew has been sent to the analyst, who analyses it and reports.

4989. Who is your analytical chemist?—Dr. Miller.

4990. Have you had him from previous years?—Yes, for many years he has analysed for us at various times.

4991. He has a laboratory of his own?—Yes, a laboratory of his own in Manchester.

4992. He now has a specimen of each brew?—Yes, of each brew.

4993. Where are these samples taken from, from barrels or from vats?—As a rule, from the fermenting rounds or from the racking vats. The racking vats are the last vessels into which the beers are run before going into the barrel.

4994. The racking vat is after it has been fermented and left to settle?—After the fermentation it is brought straight from the fermenting rounds into a large vessel containing 150 barrels or so, and there it remains for an hour or two, and then the beer is drained into the trade casks. At that point the sample is usually taken.

4995. Does that vat leave any residue in the bottom when the beer is drawn off?—Yes, it leaves a certain deposit at the bottom which goes down the drains. The vats are cleaned out every time they are emptied, and the washings run down the drain.

4996. What materials do you purchase under a guarantee of freedom from arsenic?—Practically we purchase all our materials, our malts, and everything under a guarantee of purity.

4997. (*Dr. Whitelegge.*) Does the guarantee mention arsenic in particular?—Arsenic in particular.

4998. (*Chairman.*) That is since November?—That is all.

4999. Previous to November arsenic was never mentioned?—Never mentioned and never thought of.

5000. Is there a general guarantee or is there a separate guarantee for each separate consignment?—I think for every consignment; there is a printed guarantee on every invoice.

5001. I understood that you use some grain mixed with malt?—Yes, maize grits we use, a form of maize; maize cut up by machinery and mechanically treated merely for convenience; it comes from America.

5002. Freed of the husk?—Yes, and also of the acrospire, the germ which contains flavour and oil.

5003. That is taken off?—Yes, it is taken out by the machinery. It is on the same principle as the degerminating machinery used everywhere now for wheat.

5004. Similar to what is used for the malt?—We do not use it for malt. Malt is merely crushed.

5005. In the brushing and screening there is a process of taking off the radicle, is not there?—Yes, that is the rootlets that grow outside. After the barley has been grown on the floors of the maltings, and cured in the kilns, the rootlets are brushed off, but the acrospire is there still. That is cut out in the case of the maize.

5006. For what classes of beers do you use maize?—For all the lighter beers, and all the running beers, and occasionally for some of the others.

5007. Have you ever had the maize tested for arsenic?—I think we certainly had it tested once, but of course it is pure grain.

5008. Since November have you had it tested?—Yes.

5009. What about flaked maize?—We have never used any.

5010. You have already answered the question that you used maize and have tested it for arsenic?—I think we have tested it for arsenic and found it quite free.

5011. Maize grits are simply the grain?—Pure grain.

5012. Which has not been submitted to any other treatment except the mechanical treatment you have described?—That is so.

5013. Do you use prepared or flaked maize?—No, none at all.

5014. Some forms of prepared maize may have undergone a chemical process with sulphuric acid, may not it?—I should think so, but I have no experience.

5015. But it is not the maize you use?—No, not the maize we use at all.

5016. After giving up the use of Bostock's products were any of your beers condemned as arsenical either by your own analyst or by others?—No, none at all.

5017. Have you found it necessary to destroy any beers except those in which Bostock products had been used?—None at all.

No non-Bostock beer condemned on account of arsenic.

5018. Has your brewery its own maltings?—No, we have not.

5019. Do you ever test the malt?—Yes, constantly.

5020. You test it for its value as malt?—Also for arsenic.

5021. That is since the scare you test it constantly for arsenic?—Yes.

5022. Have you found arsenic in any of the malt you have tested?—I think all malt contains an infinitesimal trace; I may be wrong, but I think it is pretty well accepted now that if they know how to find it all malt probably contains an infinitesimal trace; but that is probably being got rid of, and will in the future be eliminated entirely by kiln drying or treating with absolutely pure anthracite coal.

Drying malt with anthracite recommended.

5022*. (*Sir William Church.*) How is that to be attained?—I think some of the mines in South Wales are absolutely free. I met a gentleman the other day who told me his was, and he is selling large quantities. Before it was always a little impure.

5023. Absolutely free is strong. I would not venture to say that may not be the case, but anthracite coal we have already been told by those who know does contain in its fissures sometimes arsenic, and the public should not be too much impressed with the idea that anthracite is absolutely free?—No.

5024. (*Chairman.*) Do you do any brushing or screening of the malt?—Yes. It is screened to begin with at the maltings where we buy our malt, and it is again screened in our process. It is brushed and screened in the process in a Nalder machine which brushes and cleans it and blows out the dust before it is ground and sent up to the mash tun.

Process of brushing and screening malt.

5025. Have you in recent times ever tested the malt dust?—I do not think we have tried it. We do not collect it. It is blown into the chimney.

5026. May any of it blow about through the brewery?—No, it is drawn up into the main shaft of the chimney, where it gets consumed.

5027. It would be a satisfaction to take some of it and test it?—I think it would.

5028. If there was any arsenic on the malt at all it would be, I believe, in the outer crust?—Yes.

5029. And therefore in the test it would be found in a large proportion?—Yes. But we find our beers are so free from arsenic that we have not thought it necessary to look for a shadow of it, especially as now our maltster is producing all his malts for us with anthracite, and therefore absolutely free, I take it, or nearly as free as possible.

5030. (*Sir William Church.*) Although you have not your own maltings, you deal with one or more maltsters; you do not buy in the open market?—Not as a rule. We do for some classes of our malts, for the best pale ales, but nine-tenths of our malt is malted for us by a very well-known firm in Lincolnshire, who malt

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expressly for us under our own special conditions of growth and curing.

5031. Do they supply it to you brushed and screened?—Yes.

5032. And you also brush it and screen it yourself?—Yes.

5033. Though it has been brushed and screened by the maltster, you give it an additional brushing and screening?—Yes. That is to say, we pass it through a machine that does that. We do not expressly put it through a machine for that purpose, but the machine it passes through, which is a separator of the larger grains from the smaller ones, contains a brushing machine as well, which takes as far as possible all the dust and coombs off.

5034. (*Chairman.*) There is some dust proceeding from that process?—Yes; some considerable amount of dust is collected from that, and that passes away into the main chimney stack of the brewery.

5035. It would not be a very expensive or troublesome thing to occasionally test that dust that passes up the chimney?—No, it would not.

5036. Have you found it necessary to make any changes in your fuel?—No, we have not.

5037. With regard to this brushing and screening, are you doing that now more frequently?—No; about the same.

5038. You have been always doing that?—It has been part of our process for some years.

Brewing books show origin of ingredients in each brew.

5039. Do your books show where the materials used in the manufacture of any particular beer were bought?—Undoubtedly.

5040. Do your books show what quantities were used—the malt from one place, malt from another, and so on, in each brew?—Undoubtedly we could trace everything.

5041. Your maize from one place, and maize from another?—Yes.

But returns to Inland Revenue do not.

5042. Do the returns you make to the Inland Revenue give them this information?—No; I do not think they do. I do not think the returns give the information. All the returns to the Inland Revenue given are the quantities of the various materials required by them, but nothing as to where they come from—the malt, maize, invert sugar, and the rest.

5043. In the case of your tied houses, do you always know what brews are on the premises at any stated time?—Undoubtedly.

5044. (*Sir William Church.*) During the autumn of last year did you notice anything at all in connection with your yeast?—Nothing at all.

5045. You had not to get fresh yeast?—No.

Interchange of yeast between breweries.

5046. That does take place, the interchange between breweries of yeast?—I would not say we never do so, but it has been always our practice to periodically get a slight change of yeast, not a complete change, but about 50lbs. or so at a time.

5047. To add new yeast to strengthen your yeast?—Yes.

5048. But you had not to do that last autumn?—No; not more than usual. Every few months perhaps we have a few pounds from some brewery.

5049. (*Mr. Cosmo Bonsor.*) How much beer did you have destroyed, roughly?—Is it necessary to say it, or shall I put it in?

5050. Was it a considerable quantity?—Yes; it was a considerable quantity.

5051. Did you make any application to the Inland Revenue for a rebate?—Yes.

5052. Did they give you one?—Undoubtedly.

Rebate of duty on arsenical beer destroyed at the brewery, not if left the premises.

5053. They gave you a drawback?—On all the beers we destroyed inside the brewery.

5054. Not on the beers outside?—No; we did not ask for it, principally because we knew we should not get it.

5055. Why?—We were informed. I went to see Sir Henry Primrose, and he said there was not the least chance of allowing the rebate of the duty upon any beer that had gone outside the brewery, gone out of our hands.

5056. Might I ask if you export beer? I do not know whether you ever do export beer. If you sent it on board, they will do it?—Yes.

5057. If you took this beer out of your customers' cellars, and put it on a barge, and took it out to sea, you could have got a drawback?—I think if we passed it through one of the seaports for the purpose of export we could have done it, but I do not think it would be expedient to have done so, and they refused to allow the rebate for what was put down in the customers' cellars.

5058. They refused?—They refused. The Inland Revenue said there were objections to it, that the law did not provide for it, and that there was no chance of our getting it; all that we did was to get the rebate upon the beers that had never gone outside our own premises, and went down the drains.

Inland Revenue samples taken for revenue purposes.

5059. Did the Inland Revenue officers draw samples of your beers during the process of brewing, not for the purpose of collecting the revenue, but for the purpose of protecting the public?—Not that I know of.

5059*. Not when they got the knowledge of the epidemic?—I do not think so; only the ordinary samples for specific gravities.

5060. None for the protection of the public?—No.

Illness in brewery hands.

5061. (*Sir William Church.*) Had you noticed that there was an unusual amount of sickness among your employees, or not?—No; there were only one or two of our men of all the people we knew who had drunk our beers that had suffered. We could not trace those to our beer; they were people not living in our districts, but elsewhere. Our carters, who undoubtedly are the heaviest drinkers about the premises, were not sufferers, and there was not a single one in the least unwell.

5062. You say definitely your notice had not been attracted to your workmen, which was not the case with other places?—That is so.

Danger to health from general use of arsenical sulphuric acid.

5063. (*Mr. Cosmo Bonsor.*) I think you attribute that to the fact that you use the incriminated material in brewing and not in priming?—Yes; and also to the fact that we used no glucose, and only invert sugar. There was one question, I think, in the circular; we were asked to express an opinion as to the mode of avoiding it in future. I should like to have pointed out that from the cross-examinations and expressions of opinion, I judge a great many are inclined to believe that all danger of arsenical poisoning could be got rid of, or all dangers avoided by a system of constant analysis; but I take it that the cause of the whole trouble, and the one that ought to be attacked, is the starting point of guaranteeing the chemicals used in the manufacture of the materials. In other words, that the sulphuric acid manufacturer who is in the position of selling his stuff as sulphuric acid, should not be allowed as he is at present to sell his acid containing as much arsenic as he likes without a notice that it contains a dangerous poison perhaps known only to himself. He sells that to the sugar manufacturer; he sells it to everybody else all over the country, and I am strongly of opinion that the poison of arsenic is far more disseminated than anybody suspects. The manufacturer of sulphuric acid—the manufacturer of any other acid—can sell his product containing a poison which is not apparent on the face of it, without stating in any kind of way, although he knows it himself, that it does contain a particular poison. If the sulphuric acid manufacturer were in a position of being obliged by law, if he sold anything containing arsenic, or a hydrochloric acid manufacturer, if it contained strychnine, were such a thing possible, to place on the outside of his invoice that it did contain such a thing, the public would be protected wherever that went. I am very strongly of opinion that sulphuric acid is the cause of a large amount of danger and deaths amongst sheep stock in agricultural districts. I happen to be connected with a very large estate in Dorsetshire, which I am in a position of looking after as committee. As everyone knows, the root crops there are grown upon bone phosphate, and bone phosphate is made by treatment of bones by sulphuric acid, made from pyrites, which now everybody knows contains an enormous quantity of arsenic. It is perfectly well known in all the sheep farming districts that sheep are constantly dying whilst fed on roots from reasons nobody knows anything about. I know that the best farmers are the ones who suffer most from the loss of sheep when they are feeding on the roots, and the only way in which the deaths are put

Arsenical phosphatic manure.

an end to is by the sheep being taken off the land and put on grain food, hay, corn, and other things. Veterinary surgeons have been called down, and the most experienced farmers cannot tell what the cause is. I have given orders to have the urine collected from sheep which have died under those conditions, and I understand from analysts whom I have discussed this very question with that there is not a doubt that in consequence of the sulphuric acid manufacturers selling their acid without the obligation to divulge the presence of arsenic the poison is carried into the super-phosphate without the manure maker knowing it, and probably rendering the roots grown on it injurious to the stock. The danger would be entirely removed in the brewing industry if the original manufacturers of the materials used in the chemical manufacture of these sugars were liable to criminal prosecution if they did not state the presence of the hidden poison.

5064. (*Sir William Church.*) Of course, that is a very ingenious supposition, and one that deserves to be considered; but have you any evidence whatever to begin with that a turnip or a mangold will assimilate arsenic or take it up into its tissues? Arsenic acts as a strong poison to vegetable life as to animal life?—I was told by a chemist that arsenious acid being soluble would probably be taken up by the roots.

5065. But you have not got any evidence at present?—No, none at all at present.

5066. It is only an opinion?—Yes, it is only an opinion which has been corroborated by opinions of analysts.

5067. It is worth attending to, but you have not anything in the shape of evidence?—No. I merely illustrated that to show the danger of allowing the manufacturer of a contaminated acid to sell it without notifying to his customers the presence of poison. The whole of the danger to the public through the agency of beer would be removed by forbidding—which is the natural course to take—forbidding the chemical manufacturer to put the poison in without telling his customers, and punishing him if he does it.

5068. (*Chairman.*) You are having some experiments made on live stock?—A chemist has undertaken to analyse. It was Dr. Stevenson or Dr. Luff who originally advised me, and they told me the best way for discovering it and tracing it would be to get the urine taken from four or five sheep that had died, and if I sent it up to him he would analyse it, and if it contained arsenic he would proceed with further analysis.

5069. Is that being done?—I have given instructions to have the urine collected.

5070. If you get results will you kindly state them to Dr. Buchanan?—I will, certainly. It is late on in the year now, and it all depends on whether any stock suffer at this time of the year. The stock are not so much on roots as they would have been a few months ago.

5071. Might it not be as well to have some of the roots tested for arsenic?—Yes, I think it might. I will have that done.

5072. It would be desirable and important, and if you get results you might kindly send them to Dr. Buchanan?—I will.*

5073. (*Dr. Whitelegge.*) You suggest that fermentation might partially remove the arsenic?—I have only the supposition that the fermentation and the processes in brewing eliminate it because I have had our beers analysed, and I find only a very small trace in the worst cases. I have the authority of Mr. Gordon Salamon and others for stating that a barrel containing 4lb. or 5lb. of invert sugar ought to contain more arsenic than it actually does. I infer, therefore, that in the process of fermentation it has been deposited somewhere.

5074. Basing that inference on the fact that it has disappeared somewhere or other?—Yes, that is it. I cannot possibly say it would be so.

Colour of Bostock glucose not unusual.

5075-6. The suggestion has been made that the colour of Bostock's glucose may have been different in the later stages when it was presumed to contain more arsenic. Can you tell us anything about that?—I do not think that is at all likely. I should like to ask my brewer upon that point.

(*The Brewer.*) Certainly not; in the last two or three months Bostock's sugar was more regular in colour than it had been for some time. Some 15 or 18 months ago we had to make complaints about the colour.

5077. It was not dark at all?

(*The Brewer.*) No.

No guarantees obtained with hops.

5078. (*Dr. Whitelegge*) (*to the Witness.*) You told us you obtained guarantees of malt. Did you obtain any guarantee with hops?—We did at the beginning, but I think the hop merchants rather protested against that, as they had nothing to do with the manufacture. They said they were simply middlemen.

5079. You do not obtain any guarantee now?—No; we have had some analysed, but we do not find there is anything in it.

5080. With negative results?—Yes.

A general guarantee of purity of beer to be given to customers.

5081. Did you send out any guarantee with the beer to customers?—We have done so since this scare, but we intend to desist. It is a great source of trouble. What we intend to do is to tell all our tenants that we do guarantee it to save having to put the labels on.

5082. To substitute a general guarantee for a specific one?—Yes.

5083. Do you intend to give it to your tenants only or to everybody?—We intend to give up the specific guarantee and give the general one. If they wanted it we should always supply it.

5084. The arsenicated beer brewed with Bostock's sugar was all destroyed?—Yes.

Question of rebate of duty delayed destruction of beer.

5085. Was it destroyed at once?—It was only destroyed as it was returned to the vats and measured for the purpose of getting the Excise revenue back, but it was all destroyed in the houses as soon as we possibly could.

5086. But for the purpose of rebate was the beer retained on the premises longer than it would have been otherwise?—I think so.

5087. Can you say how much longer?—I should think there were two thousand barrels in the brewery at the time the scare occurred, and it would probably all have gone out except perhaps the pale ales within a week, and as it was a good deal of it was kept until the 28th

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* The following letter has since been forwarded by this witness:—

The Cornbrook Brewery Company, Ltd.,
Chester Road, Manchester, May 16th, 1901.

SIR,—When I gave evidence at Manchester before the Royal Commission upon Arsenical Poisoning, I stated that farmers were liable to many losses amongst sheep stock during the winter months, when sheep were being fed on roots, and that I had reason to suspect that these losses were probably caused by arsenic introduced into the roots through the fertilisers (superphosphates and other bone manures), which were, I believed, largely manufactured with sulphuric acid highly contaminated with arsenious acid.

His Lordship, the President of the Commission, desired me to make some investigations in the matter, and to report to the Royal Commission.

I now have the honour to report that I gave instructions to my agent upon the Lutworth Estate, in Dorset, to send me up to London some samples of superphosphate, and, on the suggestion of Dr. Stevenson, to procure for me, if possible, some urine from the bladder of a sheep that had died upon the roots.

I was successful in procuring a very small quantity of urine from a ewe that had suddenly died under the typical conditions referred to. The animal was apparently quite healthy, and in good condition.

The fertilisers and the urine were forwarded by me to Mr. A. Gordon Salamon, who reported that one of the samples of manure was heavily charged with arsenic, and that the urine contained more than a trace of arsenic. The quantity of liquid was very small, under a tablespoonful, and a quantitative analysis was therefore impracticable. I am informed that it was the opinion of the experts who saw the mirror produced, that the animal probably died from the effects of arsenical poisoning.

As it is impossible to believe that the arsenic could have been taken by the sheep except in the manner suggested, I think the evidence is sufficient to justify very careful investigation. The season is too advanced to allow of any examination of roots, but I hope to make further experiments next winter.

I have the honour to be, Sir,
Your obedient servant,
HENRY WELD BLUNDELL.

The Secretary,
Royal Commission on Arsenical Poisoning.

Mr. H. W. Blundell. 29 Mar. 1901.

December, when the last of the beer was put down the drains, after the Excise had taken the quantities and samples.

5088. Was there delay on the part of the Excise authorities or simply the difficulty of dealing with it?—I think the Excise officers offered us every facility, but we had to brew without cessation to make up the loss of beer we had put down the drain, and we could not spare the large vessels into which we had to pump the beer to calculate the quantities.

5089. You have large stores at other centres than Manchester?—Yes.

5090. What was done with the arsenicated beer?—It was all put down the drains in the stores.

5091. At once?—Almost at once. We keep the beers in one store where we had a considerable quantity of beer at Bolton for a few weeks whilst we were carrying on correspondence with the Inland Revenue asking them to allow us to treat that as a portion of our brewery, inasmuch as it had never been invoiced out to customers, but they ultimately declined absolutely.

5092. You did not obtain a rebate?—No, and as nothing else was to be done we poured it down the drain.

5093. You have stores at Liverpool, have not you?—No.

5094. As far as you know there was no delay at Liverpool in destroying your beer on account of the Excise?—No, I have not heard there was any.

Mr. G. E. Cowell, called; and Examined.

Mr G. E. Cowell.

5095. (*Chairman.*) You represent Wilson's Brewery Company?—Yes.

5096. You speak to the amount of Bostock's product used in your brewery. Can you give particulars in writing to the Secretary?—I have done so.

5097. How long had your firm been Bostock's customers?—About three years and a half.

5098. In respect of the action that you are now taking since the arsenic danger has been discovered, what samples of your brewing materials do you now submit to your analyst?—We have submitted malts constantly, and the sugars.

Guarantees now obtained of certain brewing materials.

5099. Brewers' sugars and glucose?—Yes, and we get a guarantee with each consignment of all the materials with the exception of hops.

5100. Have you brought any specimens?—No.

5101. Malt, invert sugars, and glucose. Are there any other materials?—No; those are the main things.

5102. Have you got a guarantee with maize?—Yes.

5103. Not in other substances?—No.

Brewing books would not show origin of ingredients in every brew.

5104. Do your books show you where the materials used in the manufacture of any particular beer were bought, and in what quantities they were used?—Our books would show where the materials were bought, but in the case of invert sugars we could not tell you positively how it is all disposed of. We did not discriminate between the two sugars before the scare.

5105. In respect to glucose?—We had only two sorts, and we should know exactly how that was used.

5106. Was your glucose all bought from Bostock's?—None of it.

5107. Were your invert sugars from Bostock's?—A portion of the invert sugar was obtained from Bostock's.

No knowledge of which brew is on sale at publicans.

5108. In the case of your tied houses, do you always know what brews are on the premises at any given time?—No; we should not know unless we went to them.

5109. You would know when it went to them, but you would not know when it was all consumed?—No, I think not, without visiting the house.

5110. (*Mr. Cosmo Bonsor.*) You keep a record of the gyles you send to each house. Do you know the particular brewing that you deliver to each house?—No.

5111. Do not you number your barrels?—Yes; but we have no record that such and such a date went to such and such a house; the date of the brewing would be on the cask.

5112. You have nothing in your books to show it?—No.

5113. You would have to go to the house to see?—Yes.

5114. Was it in the public papers that you first saw information to the effect that there was an epidemic?—We first heard of it when Mr. Groves telephoned to us and asked us if we had heard anything about it. We had not, and he asked if we had had any sickness but we had not had any sickness at all on the premises.

5115. When you first heard of it, arsenic was not named?—No.

Examination of brewers' samples by analyst.

5116. Did you first see it in the papers that the epidemic was alleged to be due to arsenic?—Yes. It was attributed, I think, to the hops, to the sulphur used in drying the hops.

5117. Did you take any steps when you heard that arsenic was suspected?—Yes; we went to the city analyst, Mr. Estcourt, and we then sent him samples.

5118. And you had a consultation with him?—Yes.

5119. And arranged to send him samples of beer on Monday after Saturday the 24th?—Yes.

5120. On Monday the 26th you again saw Mr. Estcourt?—Yes.

5121. And discussed the various theories which had been suggested?—Yes.

5122. Did you take him samples?—Yes.

5123. The samples which you gave the analyst had been brewed with Bostock's sugar?—Two of them had.

5124. On Wednesday, the 28th, you received Mr. Estcourt's report?—Yes.

5125. And that was to the effect that they were what?—That they were quite free from arsenic.

5126. All the samples?—Yes.

5127. On Thursday, the 29th, you attended a meeting of brewers of Manchester and district, when Mr. Gordon Salamon and Dr. Luff were present, and made statements?—Yes, to the effect that arsenic had been found in Bostock's sugars.

5128. You then learnt for the first time that the arsenic had been traced to the sugars supplied by Bostock?—Yes.

5129. That same evening you sent out three special travellers to withdraw certain beers which contained Bostock's sugars?—Yes.

5130. All the beers that contained Bostock's sugars?—Beers which contained a larger proportion than was usual of Bostock's sugars.

5131. And at the same time you summoned your travellers to meet at the brewery on the following morning?—Yes.

5132. And instructed your travellers to withdraw all beers of which you had any doubt?—Yes.

Destruction of inculpated beer.

5133. (*Mr. Cosmo Bonsor.*) Did you destroy a large quantity of beer?—1,389 barrels.

5134. That was beer on your premises?—Part of it on our premises.

5135. Did you get a drawback on it?—On some of it.

5136. Did you claim it on the whole?—No. We were told it was no good claiming it on the whole. We claimed on that which had never left the premises.

5137. Who were you told by that it was no good?—By the Excise.

Rebate of duty

5138. By the Excise officers?—Yes we wrote also to Somerset House.

5139. Did you write individually, or was it the Brewers' Association that wrote?—We wrote.

5140. Could you put in the answer?—Not in the exact words, but it was to the effect that the local supervisor would witness the destruction of condemned beer which had never left our brewery premises. But no promise was given whether repayment would be allowed on such beer.

5141. Could you let Dr. Buchanan have a copy of the answer?—Certainly.

5142. I understand that the beer was kept hanging about for a certain time?—Yes.

5143. I do not know whether on your premises, but certainly in some places the beer was not destroyed as quickly as it might be, owing to the doubt as to whether

the Inland Revenue were going to pay the drawback or not?—That was to some extent so in our case. We had a disused brewery; the vessels were all going to be pulled down, so that we put it there until we received a definite answer from the Excise that they could not allow rebate on it.

5144. Do you do much in the way of priming?—No, very little.

5145. You do not prime to the extent of what is allowed by the Excise?—Not perhaps 20 per cent. of what is allowed by the Excise.

5146. Do you prime with Bostock's invert sugar?—Yes.

5147. That was mainly how Bostock's invert sugar was used perhaps?—Yes, mainly.

5148. (*Dr. Whitelegge.*) Do you give guarantees with the beer you send out?—We have done so until recently, but we have discontinued it.

5149. Altogether?—Yes.

5150. You do not give any general or specific guarantee?—We have not done so.

5151. (*Chairman.*) Can you give us information as to the dates of the destruction of the beer?—The beer was destroyed as follows:—180 barrels on December 5th, at the brewery, in the presence of the Excise officer; 1,062 barrels between December 11th to 20th, at the brewery, witnessed by responsible officials; 50 barrels on January 8th, at the brewery, in the presence of the Excise officer; and 97 at various country houses in the presence of our agents.

Mr. G. E. Cowell. 29 Mar. 1901.

5152. Have you had summonses against any of your tenants?—Summonses have been taken out against six retailers of our beer; one has been fined, and the others have been adjourned pending the appeal from Mr. Headlam's decision.

5153. Have you taken precautions to test the beer you are now sending out?—Acting on the report of the committee of the Manchester Brewers' Association, dated 1st December, we have since that date sent no beer out that has not been tested and passed by Dr. Miller, the analyst appointed by the association. We have now received a notice from the Medical Officer of Health, at Stockport that a sample of our beer, taken from one of our houses on the 26th February, contained 1-50th of a grain of arsenic per gallon. I should explain that we have two breweries, one at Newton Heath and the other at Oldham. None of Bostock's sugars were used during the period in question (between June and November 23rd, 1900) at our Oldham brewery.

Beer now tested for arsenic before issue.

TENTH DAY.

AT THE TOWN HALL, MANCHESTER.

Saturday, 30th March, 1901.

PRESENT:

The Right Hon. LORD KELVIN (*Chairman*)

Sir WILLIAM CHURCH. | Mr. COSMO BONSOR.

Dr. WHITELEGGE.

Dr. BUCHANAN, *Secretary.*

Mr. SIGMUND STEIN, called; and Examined.

5154. (*Chairman.*) You are a graduate of the Imperial Royal Polytechnicum in Vienna, I believe?—Yes.

Mr. S. Stein. 30 Mar. 1901

5155. You have had nearly 20 years' experience as an analytical and consulting chemist to sugar manufacturers?—Yes, I have; and I have been for the last ten years technical manager to Messrs. Crosfield, Barrow, and Co., sugar refiners, Liverpool, and am now acting for the same firm as scientific adviser.

5156. You also hold several other positions, do you not?—I am also consulting chemist and technical adviser to several sugar factories abroad. I am a member of the Society of Sugar Technologists, a German society having members all over the world, of the Society of Austrian Chemists, and of the Society of Chemical Industry.

5157. You have been also engaged in a great deal of investigation work, have you not?—I have been engaged in a great deal of technical investigation in reference to the sugar industry, have written many articles in various scientific journals, and am scientific correspondent of nearly all existing sugar journals. I have acted as arbitrator in disputes regarding sugar, and have been repeatedly called before courts as expert.

5158. Have you considered the risk of arsenical poisoning by means of sugars?—Yes. Poisoning by arsenic through the medium of sugar may occur even in sugar refineries. It is a known fact, and a matter of elementary knowledge, that commercial sulphuric acid contains arsenic in different proportions. If such commercial sulphuric acid containing arsenic is used in a sugar refinery, poisoning may occur. In the production of crystallised sugar sulphuric acid is not used. It is, however, used in the production of so-called "golden syrup," "table syrup," or treacle. Golden syrup is made by clarifying molasses by means of animal charcoal. Molasses, the last residue from sugar refining, does not crystallise at the time it is produced. After a certain time, however, molasses commences to crystallise. This tendency to crystallisation is a great drawback in the production of golden syrup from molasses. To prevent the crystallisation of the golden syrup, the molasses are treated with a small quantity of sulphuric acid, to change or invert the saccharose into dextrose and levulose. If the inversion is properly done the golden syrup will never crystallise. For the purpose of the conversion of the molasses, the latter are dissolved to a density of about 25° Beaumé in a copper vessel provided with a mechanical stirrer, and furnished with a system of narrow steam pipes through which low pressure steam is supplied. The molasses solution is kept for about 15 minutes at a temperature of 190° Fahr. About this time diluted sulphuric acid is added. The dilution of the sulphuric acid is effected in a lead vessel, which has a graduated scale inside to determine the quantity of the acid. The quantity of acid used depends upon the purity of the sugar and of its saline contents, and varies from ·03 to 1·5 per cent. of concentrated sulphuric acid to 100 parts of molasses. Professor Wohl has studied this question, and I refer to his investigation in an Appendix. After the sulphuric acid is added to the molasses solution, and the latter has been tested, the solution is neutralised with carbonate of lime. By this addition a precipitate of sulphate of lime is formed, which is filtered off through filter bags or filter presses. The filtrate running off from the filter bags or filter presses is then sent over animal charcoal to be decolorised as much as possible, the animal charcoal retaining the impurities, and the liquor running off from it is boiled in a vacuum pan to 42° Beaumé. If the sulphuric acid is used in a

Mr. S. Stein. 30 Mar. 1901.

perfectly pure state, and is perfectly free from arsenic, no danger can occur. If, however, it contains arsenic, the latter is sure to go into the golden syrup.

5159. Will all the arsenic go into the golden syrup or only a portion of it?—All the arsenic goes into the golden syrup. The carbonate of lime used in the copper pan will not precipitate the arsenic, and the charcoal retains only a very small quantity of it, so that the bulk of the arsenic passes into the golden syrup. How dangerous the smallest quantity of arsenic in such syrup may be is clear from the fact that golden syrup is taken as food by children, and is also used in pastry making. I think that attention should be paid to this subject.

Inversion of sugar: proportion of acid needed.

5159a. (*Chairman.*) You mention in your précis Professor Wohl's patent?—Professor A. Wohl and Dr. A. Kollrepp took out a patent in Germany (No. 57368, of 11th July, 1889), regarding the inversion of sugar. Wohl and Kollrepp say that it exists for every acid a very weak concentration by which, on heating from 80° to 95° Centigrade, sugar is in from half an hour to an hour inverted to the fourfold quantity of the diluted acid used, and without decomposition and dark coloration of the resulting invert sugar.

Professor A. Wohl calculated that for an 80 per cent. sugar solution the necessary percentage of acid calculated on sugar is:—

0·01 to 0·02 of Hydrochloric acid.
0·02 ,, 0·03 ,, Bromic Acid.
0·02 ,, 0·03 ,, Nitric Acid.
0·03 ,, 0·05 ,, Sulphuric Acid.
0·05 ,, 0·20 ,, Fluoric Acid.
0·15 ,, 0·25 ,, Phosphoric Acid.
0·20 ,, 0·40 ,, Sulphurous Acid.

5160. The table given by you shows ·03 to ·05 per cwt. of sulphuric acid, whereas you told us ·03 to 1·5?—The table refers to the investigation of Professor Wohl, as given in his patent. He says that ·05 is a minimum and ·03 is a maximum of sulphuric acid as used according to his process and investigations, but I have found that these figures of Wohl are not quite according to my experience. You cannot invert properly with sulphuric acid at ·05. I have myself used over 1 per cent. of sulphuric acid for conversion in Liverpool.

5161. You say 1·5 of concentrated sulphuric acid to 100 parts of molasses; did you put in diluted sulphuric acid?—Yes.

5162. What would be the strength of the solution of sulphuric acid?—10 per cent., SO_3, or H_2SO_4, in a hundred parts of water.

5163. Then the sulphuric acid and water added gives 1·5 per cent. of concentrated sulphuric acid as a whole?—Yes; on the weight of molasses.

5164. Are you advising that it should be so done, or are you doing it yourself?—I am doing this myself.

5165. A little explanation is wanted, because it might be supposed that 1·5 per cent. of strong acid was added to the molasses, but that is not so?—That is not so. The sulphuric acid must be diluted. We cannot put sulphuric acid in a concentrated state into sugar solution. We make a diluted solution of sulphuric acid of 10 parts in 100, the ordinary diluted sulphuric acid used in laboratories of works for conversion. This diluted sulphuric acid is added in such a way that 1·5 concentrated sulphuric acid corresponds with 100 parts of the weight of molasses.

5166. Is it 1·5 per cent. added to the molasses or to the molasses and water?—The molasses.

5167. So that besides what is stated here, there is 15 per cent. of water?—That is so.

5168. Could you tell us any of the works in which this is actually done?—I have done it in the sugar refineries of Crosfield, Barrow and Co., two years ago.

5169. Have you continued to do it commercially ever since?—No. We have meanwhile stopped our refinery. We have not done any for the last fifteen months.

5170. Was this process carried out commercially for some months?—It was carried out for a few months.

5171. I think you have something to say about the addition of glucose to treacle?—Yes. It is the custom of this country to use glucose for mixing with refiners' treacle to make the latter uncrystallisable, and thus to avoid the use of sulphuric or other mineral acid in the manner above mentioned. I pass over the legal question whether the mixing of refiners' treacle with glucose should be allowed or not, and will only say that if the glucose used for mixing golden syrup is impure and contains arsenic, the same danger may be present as I have already mentioned above in regard to the use of sulphuric acid. How great this danger is may be judged from the fact that in the recent prosecutions before many police courts in Great Britain it has been shown that from 30 to 80 per cent. of glucose are mixed with 70 to 20 per cent. of treacle. That glucose may contain arsenic was proved by the lamentable case which occurred in a Liverpool glucose factory. In Schlossberger's Handbook of Organic Chemistry, p. 111, there will be found under the heading of glucose the following passage:—"Very often the glucose of commerce contains sulphate of lime or sulphuric acid. Glucose, by means of this acid, often contains poisonous metallic oxides. Payen has recommended, in consequence of this, the application of diastase for the transformation of the starch into sugar." This book was written in the year 1857, nearly half a century ago. I need not quote the reference to arsenic in glucose in Blyth's standard work on Food Analysis.

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5172. What is the date of Blyth's work?—1895 or 1897.

5173. (*Sir William Church.*) That is the last edition. Blyth's work was published, I think, in 1885?—Yes, but I think the last edition is 1896.

5174. But it is mentioned in the older edition, is it not?—I have only seen the new edition.

5175. (*Chairman.*) Do you know anything of American glucose?—Yes. I analysed commercially a great many hundred samples of American glucose, because we as refiners have been great importers of American glucose ourselves. We used this glucose for the special purpose I mentioned—for mixing with our treacle. We got large orders from abroad, especially from Switzerland, and it was prescribed by these firms in Switzerland how much glucose they wished put in the molasses. It was nothing else than American glucose mixed with a small percentage of English cane sugar treacle. They sold it in Switzerland as a kind of honey. I came to the conclusion that they used it as honey from the fact that they prescribed an abnormal density, a density which nobody in England would buy—45° Beaumé—practically a half solid mass. We had to boil it so much that it would not run out from the vat or from the mixing cistern.

In honey

5176. Is it used as honey?—So I have been informed.

5177. (*Sir William Church.*) Or rather it is used to mix with honey?—I think it will be mixed or used as an artificial honey by adding some essential flavours to it. As you probably know, there are so-called honey flavours on the market, which will give to sugar stuff a honey flavour.

Arsenic non-Bostock glucose.

5178. (*Chairman.*) Have you examined the American glucose and tested it to see whether it is free from arsenic?—I have analysed several glucoses, but I cannot remember having analysed American glucose. I have analysed English glucoses to see what was being done in this country, as I was specially interested in the glucose trade. I have made a few tests, and have found in English glucose copper and arsenic. I do not know the date of their origin.

5179. In every specimen?—In a few cases. I tried for the arsenic with Marsh's test, and with this delicate test there was only a trace. It was there distinctly arsenic. I wrote a letter to the paper, but, of course, I could not cause any excitement by mentioning that it was arsenic. I drew attention to the impurity of the glucose of commerce.

5180. Have you tested any of the Bostock glucose?—No.

5181. Of all the specimens you tested only a few contained arsenic?—Only a few.

5182. And the quantity that those few contained was very small?—Yes.

5183. Barely perceptible by the Marsh test?—Barely perceptible.

5184. Did your Swiss order specify American glucose?—No, only glucose.

5185. Did your Swiss order say that it was to be free from impurities?—No; they left it to us. They left the whole blame and responsibility to us. The buyer came from Switzerland and saw me at the works. I had a long talk with him about how the thing was

done and what kind of glucose was used, where we got the glucose from, and so on.

5186. What do you say with regard to the purity of sulphuric acid?—It is necessary to draw greatest attention to sulphuric acid. The sulphuric acid used should always be a purified acid from whatever source it may be made, whether from brimstone or from sulphur recovered in alkali works, or from the spent oxide of gas works, or from pyrites. It is very often said that brimstone acid is perfectly free from arsenic. Professor Dr. Ferdinand Fischer, of Göttingen, the highest authority on chemical technology in the world, says in his handbook (1903), page 396:—"The quantity of arsenic in sulphuric acid made from raw sulphur is mostly small, but it is larger if it is made from pyrites or blends." I have since studied the question further, and find references about the impurity and the contamination of brimstone acid with arsenic in other works. Very often arsenic was found in so-called pure concentrated sulphuric acid for laboratory use. I pointed out the existence of bad glucose in my letter to the "Liverpool Daily Post," dated 25th March, 1898. I have analysed many samples of glucose, and found in a qualitative analysis traces of arsenic. I am sure these glucoses have been of English manufacture, as I analysed at the time only English glucoses. That they were English glucoses I remember by the fact that I took a special interest in the glucose manufacture in England at that time, 1897 or 1898. I have read a statement in the papers that sulphuric acid was used in sugar refineries for washing charcoal. I think this statement was made at a public inquiry in Liverpool. This is not correct. As is well known, charcoal contains lime, and if sulphuric acid were used, sulphate of lime would be formed, which would close the pores of the animal charcoal, and would make it useless for decolorisation. A sugar refinery is a manufactory where food stuffs are made. It is necessary that there should be proper chemical control in every such factory. The chemist must analyse every raw product coming into the factory, likewise every finished product, and any materials used in the manufacture, to ascertain their purity. If a poison is used, or an article which may contain a poison, every lot of this material must be analysed to ascertain its freedom from the poison. If in a sugar factory poisonous materials are used, every lot of sugar turned out ought to be analysed for poison. The samples must not be taken from a big bulk, but from small quantities, as it is impossible to get an average analysis from a large quantity of sugar. From time to time samples of sugars should also be sent to a public analyst, so as to have the analysis of the factory chemist checked. All such analyses should be recorded in a book. Poisons are often used in sugar-works, say, sugar-works in Germany, France—I will not say Austria. So, for instance, the baryta process raised the suspicion of the Government, the health authorities, and of the public analysts.

5187. Is that in Germany?—Yes; there are many other processes where poisons are used, for instance, lead. In desuration works it is often the case that sugar is made from molasses by the lead process. This process is not so much used now as it was 10 or 15 years ago. In mentioning the Baryta process I recall to mind an incident. A sanitary inspector from the Berlin office came to the factory, and said, "If we allow you to use this Baryta process, if the sugars turned out by the process are free from Barium, well and good; but if the smallest trace of baryta is found in your sugar we shall close your factory." They watched the sugars, and the manufacturers, to make sure, did not depend on their own chemist, but sent the material for analysis to a Government and public chemist, practically throwing the responsibility from themselves on to the Government laboratory, thus making themselves safe against prosecution. Very often phosphoric acid is used in sugar factories for the purpose of decolorising and clearing the juice and also from clearing the sugar-juice from lime. I have frequently found commercial phosphoric acid containing arsenic. By the use of phosphoric acid containing arsenic, the latter can also pass into the sugar. Phosphoric acid is also used in the preparation of golden syrup in a similar way to sulphuric acid, and in several of the beet sugar factories. If this phosphoric acid contains arsenic, beet sugar also may be contaminated with arsenic. I have myself a patent for the refining of sugar without charcoal, entirely with chemicals. The principal agent is peroxide of hydrogen. I was the first to introduce, 12 or 13 years ago, peroxide of hydrogen into sugar refineries, and since that time several other patents have been taken out by Frenchmen and Germans. In this process I used phosphoric acid. Phosphoric acid is a great decoloriser, and it is also used for precipitation of the last traces of lime. This phosphoric acid and phosphates are used in a great many cane sugar factories, raw sugar factories, and refineries, both in the British Colonies and foreign colonies.

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5188. How do you get your phosphoric acid free from arsenic?—The danger of phosphoric acid containing arsenic comes from the sulphuric acid solely. Phosphoric acid is made from phosphates or bone ash—from natural phosphates, but mostly from bone ash. Arsenic in phosphoric acid.

5189. Is there a liability for natural phosphates to contain arsenic?—I have never analysed natural phosphates.

5190. Does bone ash sometimes contain arsenic?—Bone ash not, but for making phosphoric acid spent charcoal is used, charcoal which has been turned out from refineries because it has lost its decolorising power. This charcoal is burnt to burn off the organic matter, and the ash is used for making phosphoric acid containing phosphates of lime. If the charcoal contained arsenic I am not sure whether some might not be found in the ash.

5191. In every case you test the phosphates for arsenic?—The phosphoric acid must be tested for arsenic, and I do so repeatedly.

5192. Did you do that before the recent epidemic?—Yes.

5193. Several years ago?—Five or six years ago.

5194. You tested the phosphate for arsenic?—Yes.

5195. Did you frequently find arsenic in your tests?—I found it in two cases.

5196. Out of a large number?—Not a large number. I should say I only found traces. The people I bought the phosphoric acid from did know that I used it for sugar refining. I bought it on the Continent and I bought it from Scotch manufacturers. They have been always free from arsenic. I found arsenic in two or three consignments from German manufacturers, one of the largest manufacturers in Germany, in spite of the fact that I told them I wanted it for sugar refining, and free from arsenic. As there were only very small traces I used them.

5197. Is the use of sulphuric acid in molasses a general usage, or is it only in your own factory?—That brings me to a point which I wish to mention. In this country, in most households golden syrup is used. There is a big trade in golden syrup, and a great number of factories make a speciality of it. They make more golden syrup than sugar. They sell so much golden syrup that the residue which they would get from the refinery is not sufficient to cover the demand, and the price they get for this golden syrup is so profitable that they make it direct from sugar. They take raw sugar or half refined sugar—raw sugar may be white, but is sugar not purified in a sugar refinery, like French No. 3 crystal—and use thousands and thousands of tons every year for making golden syrup only, sugar transformed and inverted into golden syrup. Use of sulphuric acid in making syrups.

5198. Inverted by sulphuric acid?—Yes. That is done to-day. I should say, at the rate of ten to fifteen thousand tons per annum, or it may be twice or three times as much as that.

5199. Is there any way of converting crystallised sugar into what would be suitable for golden syrup except by sulphuric acid?—No. I have tried myself with sulphuric acid and with hydrochloric acid, but the great disadvantages I have found with hydrochloric acid is that you have to neutralise the acid, which can only be done with carbonate of soda, which leaves chloride of sodium in solution. I put very little hydrochloric acid in, keeping to the limits of Wohl, but it was unsatisfactory. When I used a very small quantity of hydrochloric acid I did not neutralise; I left the acid in the syrup. I dissolved the sugar to a certain density, and put a certain quantity of hydrochloric acid in. The sugar was converted, and without any neutralisation I filtered the acid solution off mechanically, through filter bags, and sent it over animal charcoal. It left the whole thing acid. I evaporated in a vacuum pan and boiled it down to a syrup. The syrup which was turned out was very slightly acid.

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5200. **Did the hydrochloric acid go away in the evaporation?**—Yes. This stood very well for two or three months, and I was highly pleased with my invention. I tried mixing the treacle or golden syrup with glucose, but after two or three months, especially in summer time, when the syrup was distributed amongst grocers and put into warm places or exposed to the sun, it crystallised. I had put too little hydrochloric acid in. I did not put it as stated by Hertzfeld, one to one. Hertzfeld's investigation showed that inversion should be done in such a way that saccharose should be in a certain proportion to dextrose and levulose. It was one to one, and I did not go as far as that.

5201. And the result was that the golden syrup crystallised?—It crystallised to a perfectly solid mass, and we got the syrup back in cardboard boxes instead of the barrels it was sent out in.

5202. **Was not the syrup objected to on account of the acid itself?**—No, it was only slightly acid. I tested for hydrochloric acid, but it was only very slight. The slightly acid reaction of the golden syrup made the syrup more palatable; it had not the dead sweet taste of the golden syrup. In speaking about the taste of golden syrup, I may say that the more inversion takes place and invert sugar is formed the more agreeable is the golden syrup. Saccharose has a very nasty taste, whereas invert sugar on account of the levulose has a more pleasant taste.

Most glucose arsenic-free.

5203. (*Mr. Cosmo Bonsor.*) **Is there any reason why arsenic should not be kept entirely out of glucose?**—There is no reason. 99 per cent. of the glucoses made are free from arsenic.

5204. **If there was a legal penalty for arsenic in glucose the manufacturers could keep it out without difficulty?**—Certainly. I have heard it stated that nearly all glucoses contain arsenic, but I should reverse that and say from my long experience on the Continent and in this country in glucose factories that arsenic in glucose is the exception, and the rule is that glucoses do not contain arsenic.

5205. **Do you say the same with regard to invert sugar?**—Yes

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5205-7. (*Chairman.*) **You wish to put in a letter that you wrote to the *Liverpool Daily Post*?**—This is a copy of the letter which I wrote:—

BREWING SUGAR AND PURE BEER.

To the Editor of the *Liverpool Daily Post.*

SIR,—Your leader in to-day's issue very clearly hits the point on the beer question. In mentioning the experiments made with brewing sugars on cats, you quoted the evidence of Dr. Schidrowitz and Dr. Tunnicliffe, "that brewing sugar residues produced vomiting, whereas the residues of all-malt beers were quite normal, no symptoms of any kind having been observed."

There is a great difference in the character of brewing sugars. I have analysed and investigated many samples as a private hobby, and have come to the conclusion that where brewing sugar is used it should be in certain proportions and of a certain analysis, which should be prescribed by an Act of Parliament.

The question is of such great importance to the general health that some restrictions and regulations should be made, such as is the case in the sale of manure and feeding stuffs, when the analysis must be given; and it should also be made imperative that the Excise authorities in breweries, the brewer himself, as well as the health authorities, should be informed of the full analysis of every substitute used in the brewing, especially the brewing sugar, and that such analyses should be stated on the invoice by the seller.

Yours, etc.,

SIGMUND STEIN.

214, Upper Parliament Street, March 25th, 1898.

Professor SHERIDAN DELÉPINE recalled.

Prof. S. Delépine.

Quantitative tests for arsenic by Reinsch method

5208. (*Chairman.*) **We took part of your evidence yesterday, and you were going to hand us in the name of the brewery from whom you got a sample of beer marked "Private" in Table 1?**—Yes. (*The name of the brewery was given to the Commissioners.*) Might I add a few words as to the manner in which we ascertained that the test we used was accurate? Firstly, we compared our results with those obtained by Professor Dixon, who had kindly undertaken to analyse portions of three of our samples (beer, glucose, and sulphuric acid) by the usual methods. On several occasions the same specimens were examined with perfectly identical results. Secondly, we had sent to us on two occasions samples which were supposed to be of different origin, and we found by testing that the quantity of arsenic found was exactly the same. On further enquiry it was discovered that two samples of the same beer had been sent to us.

in beer; quantity of beer used.

5209. (*Sir W. Church.*) **Certain of the beers that you tested I see marked in this table (Appendix, No. 12, p. 346, Table I.), with a nought with a query; N, for example, is so marked, and the Munich beers have a nought without a query. That means that there was no trace of arsenic in them?**—So far as we could ascertain there was no trace. In the case where a nought has been entered, we have not only tested the usual quantities of beer, but have gone up to one litre of beer which is 10 times as much beer as we have used in most of the other cases. The quantities are all put in the table.

No arsenic found in Munich beer,

5210. **But in these beers you used a larger quantity?**—Yes, a larger and larger quantity until we found that test after test would reveal absolutely nothing. That dark lager beer which I have tested has been used as a diluting fluid for a great number of materials in order to have a substratum always of the same composition, not water. This beer has been tested, I should think, 50 times as a matter of control in the course of the investigation, and we have never been able to obtain a sublimate of arsenious acid from it. We have not used the light lager beer in the same way, because although we could not get any sublimate from it there was always a slight darkening of the copper.

5211. (*Mr. Cosmo Bonsor.*) **Whose beer was it?**—I could not say. The actual name of the brewer was immaterial to me. I simply desired to actually get a sample of Austrian beer.

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5212. **Are you quite sure it came from Vienna, because there is beer in England sold under a foreign name?**—It was imported by Moellers here, who are large importers, and they guaranteed that the beer came from Vienna, and gave me the date of the consignment. I have also examined some samples of English beer, which showed no distinct evidence of the presence of arsenic.

or in some English beers.

5213. (*Sir W. Church.*) **Was this beer you referred to an English beer?**—Yes, and it was practically free from arsenic. We have tested several samples of English beer, especially from the South, which contained only very slight and unimportant traces of arsenic. They have not been included in the table, because this report only contains what was done for the Salford inquiry. All the other experiments or analyses have been carried out at my own expense, and were quite unofficial.

5214. **Had you introduced into this table your experience of beer generally, southern beer as well as local beers, there would have been a larger number to which you would have placed a nought, or a nought with a query?**—Yes, nought with a query. In some of them the traces were so small that they were immaterial.

5215. (*Chairman.*) **How did you apply your method to materials other than beer?**—The soluble substances were dissolved in 100 cc.'s or 200 cc.'s of dilute pure hydrochloric acid (1 part of acid to 5 parts of water). Instead of water, arsenic-free beer has been used, whenever possible, in order to render results more comparable. Some experiments seemed to show that the precipitation of arsenic took place more readily from solutions of arsenious acid in beer than from solutions in pure water. Insoluble substances such as malt and hops were suspended in a sufficient amount of dilute hydrochloric acid (1 to 5), from 100 to 200 cc.s of fluid were used. These substances were usually macerated for several hours before the tests was applied. Sulphuric acid was neutralized with pure ammonia before being tested.

5216. **Can you summarise your results?**—Yes. A summary of the results of analyses of various products

12, Tables I. to IX.). These nine tables relate to the following materials: Beer, malt, hops, glucose, invert sugar, fuel, raw material, of brewing sugars, sulphuric acid, and other materials used in glucose making, and, lastly, an estimation of arsenic in a particular sample of urine of a beer drinker. In each instance I have given (a) the amount of arsenic estimated as arsenious acid in 10 million parts of material analysed in each case; (b) the quantity of the poison, estimated in grains per gallon in the case of beer, and per pound in the case of other substances; (c) the largest and the smallest amount of material analysed; (d) finally, in the case of brewing material I have calculated in each case the maximum amount of arsenic which each article might introduce into a gallon of beer.

5217. What is your opinion of the exactness of the quantities obtained by your test?—These quantities are only approximate, but they are never in excess of the quantity which is present in the beer. This has been ascertained by making solutions of known strength and trying to recover the arsenic present in these solutions; and it was always found that we could estimate with close approximation the amount we put in. The differences which can be estimated by the test I have devised are much under one-thousandth of a grain, so that although the method is only approximate it is a very accurate method compared to many other methods of analysis.

5218. Your quantitative result is founded on a comparison of standard specimens?—Yes, it is a purely empirical method, but carried out with reasonable care, it yields results which can be relied upon, and which are at least as correct as those of good volumetric methods of analysis usually are.

5219. Your standard specimens are kept from week to week; do they alter at all with time?—They have not altered yet during this investigation, but we have prepared new sublimates from standard solutions, and they corresponded exactly to our original standards, so that up to now our first standards have proved to be quite reliable.

5220. Do your standards show the difference between 1-20 of a grain per gallon and 1-25 of a grain per gallon?—No. We have not attempted to estimate by direct comparison such small differences as that. We have made a number of sublimates, and we have selected those sublimates which were quite distinct from each other both to the naked eye and under the microscope. We found the most convenient for use—those made with 1-100 milligrams in 100 cc., or 1 in 10 millions; 1-20 of a milligram in 100 cc., or 5 in 10 millions and 1-10 of a milligram in 100 cc., or one part in a million (1 part in 10,000,000 corresponds to 1-143 grain, say 1-140 grain per gallon). With these three standards it is always possible to say whether a sample contains more arsenic than one of the standards, and less than the next standard above it. The differences are so marked that there is no difficulty in estimating the place of the sample examined between two standards. The differences are sufficiently small to make the estimation accurate enough for all practical purposes.

5221. We have had evidence as to one set of specimens of beer in which different analysts found different results. One analyst found 1-40 of a grain per gallon, the Somerset House authorities found 1-30 of a grain per gallon, another analyst found 1-15 of a grain per gallon, and another one found 1-5 of a grain per gallon. Would your test distinguish between 1-20 of a grain per gallon and 1-30 of a grain per gallon?—Yes, by taking into account the amount of beer analysed and that of sublimate obtained—I have explained in answer to a previous question (4929) that when an accurate estimation is wanted, several tests are applied in succession. The first test, for which 100 cc.'s of beer are used, indicates roughly the amount of arsenic. The second test is made with a quantity of beer which should contain, according to the indications of the first test, an amount of arsenic corresponding to one of the standards. By this second test a further approximation is obtained, which is generally sufficient for practical purposes. At this stage the approximation is generally within 1-70 grain per gallon. By a third test the margin of error can be reduced to 1-140 grain per gallon. It is, therefore quite easy to distinguish between 1-20 and 1-30 grain per gallon.

5222. Would you expect a public analyst to be able to distinguish decidedly between 1-20th of a grain per gallon and 1-30th of a grain per gallon?—He should be able to do so easily.

5223. And a public analyst, with time given to him and the circumstances considered, ought certainly to distinguish between 1-20th and 1-30th of a grain per gallon?—Yes. It would take him between two and three hours to do that. If he started originally with a quantity of beer which gave a sublimate exactly corresponding with one of his standards by a single estimation, taking about an hour, he would be able to give an exact amount. If he did not happen to hit upon the exact quantity of beer necessary to obtain a sublimate corresponding to a definite quantity, then he would have to repeat the test a second time, and sometimes a third time, this would take him two or three hours according to the number of tests he had to apply.

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5224. The differences I referred to were given in evidence in a law case, somewhat to prove that able men, public analysts, found it a very difficult thing to make sure of?—I think a great part of the difficulty is due to there being no fixed method recognised for the estimation of arsenic. It is well known that the various rapid methods of analysis in common use, even when carried out very carefully, give different results. The estimation of extremely minute quantities of arsenic is always a matter of very great difficulty, and the results of different observers who use different methods in the estimation of very small quantities can seldom be compared.

5225. Would you think that such large discrepancies as those I mentioned, 1-40th of a grain per gallon by one, 1-30th by another, 1-15th by another, and 1-5th by another should occur?—I certainly would take the Somerset House authority as being one upon which the magistrates should rely.

5226. You would not think the magistrates were entitled to dismiss the case because four analysts gave four different results?—Certainly not. I think it would be a case rather for postponing judgment than for dismissing.

Arsenic recovered more easily from beer than from water with Reisch test.

5227. (*Sir William Church.*) What are your reasons for thinking that in some cases precipitation of arsenic takes place more readily from solutions of arsenious acid in beer than from pure water?—On three different occasions we made arsenical solutions of the same strength in pure water and in pure beer, and we found that the sublimates obtained from the solutions of arsenic in water were smaller than the sublimates obtained from the corresponding solution of arsenic in beer. The three sets of analyses gave very nearly the same results, and it seemed to me that the presence of organic matter in beer accelerated the precipitation of arsenic on the copper. It was quite unexpected. We thought that the reverse would occur. But these are the facts we obtained, and they want to be investigated very much more carefully, because they may be of some importance.

Question of combination of arsenic with organic matter of beer.

5228. So far as those investigations go, it would rather suggest that one of the difficulties which has been placed before us by other chemists is not likely to be true, and that is, that it is possible that arsenic in combination with organic radicals would not be so easily detectable by the modified Reinsch test as when it was not in combination with organic radicals?—That is exactly the point I wanted to test, and I found there was no evidence whatever that arsenic was more easily precipitated from watery solution than from a solution in beer. On the contrary, arsenic present in beer was very much more easily recovered than arsenic in water.

5229. So far as your present investigations go, they would rather tend to show there is no likelihood of arsenic escaping observation because of its being in combination with organic substances?—There is not the slightest evidence of that being the case. I have made a special investigation of that point, which I propose to refer to afterwards. Another point about which some difficulty arose was the state in which the arsenic was in beer—whether it was suspended as a precipitate, or whether it was a soluble compound, such as an arsenite or arsenious acid pure and simple. In order to ascertain whether part of the arsenic present in the glucose or in the wort was in the form of a precipitate, or whether, as I had supposed, all the arsenic was in solution, the following experiment was made. To 100 cc. of slightly arsenical wort, 1·67 grammes of strongly arsenical glucose was added. After a time a portion of the turbid fluid was filtered through porcelain. 10 c.c. of the unfiltered solution, and 10 c.c. of the clear filtered were then tested in the usual way, and it was found impossible to

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discover any appreciable difference in the amount of arsenic present in the filtered and the unfiltered fluid. The arsenic was, therefore, in the form of a soluble compound, both in the glucose and in the wort probably some arsenite, for other evidence shows that the presence of arsenic acid and arsenates is improbable. This additional test supports the view that all the arsenic in beer is in the form of arsenious acid, or some soluble arsenite. These are the two samples. (*Samples shown.*) The filtered sample yielded exactly the same amount of arsenic as the unfiltered sample.

5230. (*Dr. Whitelegge.*) The experiment you have described would not show whether the arsenic was in organic combination or not, would it?—No, it does not show that; it simply shows that one has to deal with a soluble compound which is equally diffused throughout the whole fluid, and the results of other tests are exactly the same as those obtained with solutions of arsenious acid, or arsenites. Arsenious acid and arsenites dissolved in beer gave the same reactions as did the incriminated beer. This experiment shows certainly that we had not to deal with a precipitate like sulphide of arsenic.

5231. You told Sir William Church that you thought the ready precipitation of arsenic from beer showed that the presence of organic matter possibly accelerated the deposit?—That is the impression which the results have given us.

5232. Would that extend to cases in which arsenic was in combination with organic matter? If, for example, you had cacodyle, or an organic compound of arsenic of that kind, would the arsenic be deposited on the copper?—I have not gone yet much into that part of the question, because cacodyle would give such a very bad smell to the beer that its presence would have been evident. I have tasted the samples of beer, and smelt them all, and found no evidence of it.

5233. I was thinking of the suggestion that the arsenic might be in combination with organic matter, not as cacodyle necessarily, but in some form, and I wanted to know if you could tell us whether if it were in that combination it would be deposited on the copper in Reinsch's test?—I am not certain it would. I cannot yet give the results of actual experiments. The other results showed it is not likely that arsenic was in the presence of arsines or other organic compounds, because all those which might reasonably be expected to occur in beer are generally much less poisonous than the compound which was actually present in the beer. The toxicity of the beer was exactly similar to that of a solution of arsenious acid or arsenites. This was proved by several experiments. A summary of some of the recent work upon the physiological action of arsines is given in E. Wortheimer's article on arsenic in Richet's Dictionnaire de Physiologie, 1895, p. 701.

5234. (*Chairman.*) It would be the same as that of an equal quantity of arsenic in Fowler's solution?—Yes, it behaved exactly like Fowler's solution.

Explanation of accompanying tables.

5235. On what basis do you calculate the maximum amount of arsenic that would be given by each ingredient to a gallon of beer?—This calculation has been made in the case of malt and hops on the supposition that the largest possible amount of material had been used in brewing, whilst in the case of malt substitutes, the average amount acknowledged to be used has been the basis of calculation. It will therefore be evident that in the case of malt the calculated amount of arsenic has been probably often over-estimated to the extent of over one-fifth of the number given, whilst in the case of malt substitutes there is a variable degree of under-estimation. I say one-fifth, because one-fifth at least of the malt is replaced by malt substitutes when brewing sugars are used.

5236. (*Sir William Church.*) That is to say, you have considered that a beer you have had to examine has only had 25 per cent. of glucose when it might have had 40?—Yes. We have taken the minimum which is recognised to be suitable for good brewing.

5237. Which would be about 25 per cent.?—About that. There is one part of solid substance to four parts of finished beer, and of that one part of solid substance a certain proportion which otherwise would be malt is replaced by glucose or invert sugar. I have based my calculations on the supposition that that quantity was about one-fifth.

5238. Is there no way by which in the finished product it could be discovered what quantity was added?—I am not sure about that, but this question did not come within my line of work. I do not think it would be altogether impossible to find that out.

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Arsenic in Botsock sugars.

5239. (*Chairman.*) As regards the arsenic in Bostock's glucose and invert sugar, can you reckon what it may have been from your knowledge of the quantity of arsenic in the sulphuric acid used?—The amount of arsenic which passes from sulphuric acid into glucose or invert sugar can only be surmised, but supposing that the best flour be used, about 5 per cent. of sulphuric acid would be required to obtain the conversion of 1lb. of that flour into 1lb. of glucose. Supposing again that all the arsenic contained in the amount of sulphuric acid used to make 1lb. of sugar was retained, each pound of sugar would, on the basis of the lowest estimate, contain at least five grains of arsenious acid. But as the mixture of sulphuric acid and newly-prepared glucose is submitted to various processes (neutralisation, passage through charcoal, and sometimes bleaching) before the sugar is ready for use, it is difficult to say how much of the arsenic remains in the glucose. The charcoal should abstract large proportions of arsenic. It must, however, be remembered that the charcoal obtained from the Bostock factory yielded both before and after reburning a large amount of arsenic; it is probable, therefore, that filtration through such charcoal could not have had a very beneficial effect. That this was the case is shown by the quantities of arsenic found in some of the samples of glucose, which, judging by their appearance, had been decolorised by charcoal. Pale glucose 23, Table IV., contained over four grains of arsenic to the pound. So that the charcoal used in that case cannot have done much in the way of removing arsenic. Although it is impossible to calculate with accuracy the actual amount of arsenic introduced into the sugars by sulphuric acid, it is clear that the acid contained more than enough to account for all the arsenic found in the brewing sugars. The flours were free from arsenic, and the sulphurous acid used for bleaching contained only a small amount of it. The following quotation taken from a letter I have received from Dr. Thorne, the chemical adviser to Messrs. Garton, Hill, and Co., shows that the amount of arsenic taken up by the glucose must be influenced to a certain extent by the nature of the starchy material employed. "Theoretically, pure dry starch should give 111 per cent. of dry glucose, and pure dry sugar 105 per cent. of dry invert sugar. But commercial starches contain from 10 to 20 per cent. of moisture and minute quantities of fibrous or cell matter, and commercial flour 10 to 20 per cent. of moisture and a varying but appreciable quantity of fibre. Raw sugars contain varying proportions of moisture and of foreign organic matters, removed during the conversion and purification. On the other hand, it is not practicable to prepare commercially either invert sugar or glucose in the dry state. Solid glucose and commercial invert each contain about 18 per cent. of moisture. In practice the quantities obtained are approximately as follows, varying, of course, slightly for different lots of material:—

Proportion of sulphuric acid used in glucose.

100 tons starch yield 100 to 102 tons glucose.

100 tons sago flour yield 95 to 98 tons glucose.

100 tons tapioca yield 93 to 98 tons glucose.

100 tons raw sugar yield 106 to 108 tons glucose.

For the conversion of starch about 4 per cent. of sulphuric acid (70 per cent. acid of specific gravity 1·600) is required, for flour 5 to 6 per cent., and for sugars 1 to 2 per cent. These percentages are calculated on the weight of raw material." This information from Dr. Thorne shows that it is practically impossible to calculate accurately the amount of arsenic that will be retained, but that approximately this can be done tolerably well.

5240. (*Sir William Church.*) Do I understand that the charcoal Messrs. Bostock were using contained arsenic before it had been in the filters?—Yes, I understand that the charcoal is used over and over again.

5241. That I understand. But I want to know whether you examined any charcoal that they were using before it had been in the filters at all?—No. We examined what I suppose they would call new charcoal, which was really old charcoal re-burnt.

5242. But you did not examine the pure material in the first instance?—No. We had no chance of doing that.

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5243. (*Chairman.*) As regards arsenic in malt, I see from your table No. 2 that you found it to vary between nothing which was detectable by your test, and one-fifty-seventh of a grain per lb. approximately?—That is so.

5244. (*Mr. Cosmo Bonsor.*) If arsenic is excluded from sulphuric acid and from the fuel used for drying malt and hops, the beer would, in your opinion, be practically free from arsenic?—I think so. I think there would, as a rule, remain so very little arsenic in the beer that it would become practically free from injurious quantities of arsenic. One has to distinguish between the amount of arsenic which might possibly produce some mischief. The amount of arsenic which produced the outbreak was almost entirely due to the sulphuric acid. The amount of arsenic which is now thought, as a matter of speculation, a possible source of danger, must have been introduced by malt.

5245. From the fuel?—Yes.

5246. I say practically free, because of the query you placed with the nought. There may be the smallest possible trace, but they are free as far as circumstances admit?—Certainly.

5247. (*Chairman.*) With regard to the investigation of arsenic in fuel, what have you to say about that?—All the samples of coal or coke examined were found to contain arsenic. Two samples of anthracite used by two different maltsters were found to contain only minute quantities of arsenic, but it is possible that even after this material has been finely pulverised and treated with hydrochloric acid, some arsenic escapes detection by Reinsch's method. Four samples of gas coke were found to contain 1·46, 1·17, 1·14, and 1½ grains of arsenic per lb. respectively; possibly the whole amount present was not detected in all cases. It is almost certain that a larger amount of arsenious acid is liberated by combustion than these estimates by Reinsch's test would indicate. I collected some of the soot deposited in an ordinary chimney where South Yorkshire coals had been burnt for one week, and found that the soot contained 5½grs. of arsenious acid per lb., arsenic estimated as arsenious acid. I collected the soot which had collected in one of the flues of a small closed stove, in which coke from the Manchester Gas Works had been burnt for a fortnight, and found that the soot contained about 28 grains of arsenious acid per pound. In the 113 grammes of soot which had collected in a small flue there was about ½ gramme of arsenious acid—2 grains of such a soot would be enough to introduce into 1lb. of malt the amount which was found to be present in a sample of unscreened and unpolished malt. (No. 111 of Table 7.) The presence of this large amount of arsenic in the soot causes a marked arsenical contamination of the air in Manchester, and may account for the bad effect of this air on vegetation. From 30 grammes leaves of evergreens in my garden, which is not in the centre of Manchester, I obtained arsenic in sufficient quantity to make its detection easy, the amount being quite measurable (1-350 grain per pound). It is probable from this last observation that by using a delicate test minute traces of arsenic would be detected in many vegetable products, including hops, which had been exposed from time to time to air loaded with smoke from coal or coke furnaces or domestic fires. Soot may be carried in this way to considerable distances from manufacturing centres. It is, therefore, a question whether mere traces of arsenic in hops or barley can be entirely avoided. Malt and hops stored up in certain storehouses would also be exposed to a certain amount of contamination; a sufficiently delicate method of analysis would probably reveal traces of the poison in such materials. It is practically useless to push the method of analysis beyond a certain degree of delicacy, or we shall find arsenic in almost everything.

5248. Would there be arsenic in the dust on the top of bookcases, and so on?—Yes.

5249. Have you examined the ordinary dust in houses?—We have examined it, but we have not exactly estimated the amount of arsenic, and I would ask leave to add this estimation to the end of my tables.

5250. There is, I suppose, sometimes arsenic in the dust of years found on the top of a bookcase?—That dark dust in Manchester contains arsenic.

5251. But you have not measured it yet?—It has been partly done, but the estimation is not completed.

5252. (*Sir William Church.*) Is it not rather a new discovery that there is such a large quantity of arsenic in common soot as is shown in your table? It was always known there was arsenic present where you got double sulphides or iron and pyrites in coal, but was it generally known that the soot contained so much arsenic?—I do not think it was known that the quantities were so large, but there was some knowledge of the general distribution of arsenic. Chemists who work at the detection of arsenic are extremely careful in their laboratories to avoid carrying out experiments which could cause dissemination of arsenic in the laboratory by dust.

Arsenic in soot.

5253. Was it ever suspected that there were 28 grains of arsenious acid in a pound of soot from the flue of a stove?—I do not think so, but when the facts of the case are considered this is not extraordinary because the coke itself is frequently made from very arsenical coal. All the samples of coke we have examined, retort coke, purified coke, and ordinary coke, contain arsenic. The effect of burning coke in a closed stove is practically to produce a distillation of arsenic and a formation of arsenious acid, just as if one intended to prepare arsenious acid for manufacturing purposes.

5254. It was the quantity that astonished me, not its presence?—The quantities astonished me at first. I was very much surprised to find them. You will notice that the quantity of material used for detecting the arsenic had to be gradually reduced to two-hundredths of a gramme. There was so much arsenious acid in the soot that we had to reduce the amount of soot for estimation to ·025 before we could get a deposit that was small enough to be be estimated.

5255. (*Chairman.*) It was too large?—Yes. At first we could not do anything, because there was so much arsenic in the material.

5256. Would it be easy by a special process to separate that 28 grains of arsenious acid from the soot?—It would be extremely easy. A simple washing would do it almost. It is in the form of arsenious acid chiefly, and could be separated by washing the soot with water.

5257. Or with a solution of potash?—An alkaline solution would remove it very much more rapidly than water.

5258-9. (*Dr. Whitelegge.*) You are going to tell us about the proportion of arsenic in Manchester dust?—Yes. The analysis is not completed. I went to the laboratory this morning to see if it was finished, but it was not.

5260. Are you making investigation about country dust?—I have not begun that yet, but I have made arrangements to do so.

5261. I suppose in country dust you would not anticipate anything like the same amount of arsenic, because it would not be so largely composed of soot?—I would not expect any far away from towns.

5262. Then hops growing in the country would not have much soot and arsenic condensed on their surface, would they?—Not much. I was considering a special case. I lived for some time at a distance of eight miles from Manchester, in Bowdon, where a number of shrubs had been gradually destroyed owing to the passage over the town of the smoke from various manufacturing towns, which are at various distances. Even in the hop districts there are several manufacturing centres; for instance, Reading is not far from certain hop districts, and it is not at all unlikely that soot from the chimneys there would be carried a distance of a few miles.

Need for standard tests for arsenic.

5263. (*Mr. Cosmo Bonsor.*) There are large Portland cement works which must make a considerable amount of smoke all down the Medway?—Yes. I am speaking only of traces, and not of material quantities. My object is simply to show that the delicacy of the test for arsenic must be determined, or else the results will become practically useless.

Arsenic in coal.

5264. (*Chairman.*) In burning ordinary coal in an ordinary fireplace, is as much arsenic produced as with coke fires?—Not so much, but I have given in my tables the quantity obtained from South Yorkshire coal, which I use in my house, and the quantity there was 5½ grains per pound.

5265. The less sulphurous coals would contain less arsenic?—I should think so. I suppose it is the presence of various ores in coal beds that gives rise to the presence of arsenic in the coal. Pure coals like anthracite contain so very little arsenic that it is not always easy to detect its presence.

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5266. As a physiologist, do you think that breathing the air of a smoky town has any perceptible effect in respect to arsenic?—I would not like to make any definite statement on that point, but I have a suspicion that soot from towns where arsenical coal is used is far more irritating to the lungs than pure coal dust. The reason why I say so is, that I have noticed there is generally more fibrous tissue produced in the lung in town anthracosis than when the coal is inhaled as dust, as, for instance, in the case of coal miners; I find the lungs of coal miners may become as black as soot, and all the lymphatic vessels entirely distended with ordinary coal dust, without there being evidence of very distinct inflammatory reaction; whilst on the contrary in towns, where the amount of carbon collected in the lungs is smaller, there are frequently capsules of fibrous tissue in the lungs around small masses of carbon which have accumulated, indicating some irritating action on the part of the soot.

5267. So that we may take it the atmosphere of a coal mine is more salubrious than that of the City or West End of London?—That is what it comes to, except that there are other conditions not so favourable in coal mines as in the West End of London.

5268. (*Sir William Church.*) There are many other things besides arsenic which would account for that. Of course, you have not sulphurous acid in the coal mines?—Undoubtedly there are other things than arsenic. But at the same time arsenic being present in such a large amount in soot becomes a far more important factor than sulphurous acid, which probably rapidly disappears.

5269. Although it rapidly disappears, you can taste sulphurous acid in a London fog?—Yes, and it is there not worse than in Manchester.

Arsenic in yeast.

5270. (*Chairman.*) You have also some experiments to put before us as to the action of yeast in regard to arsenic?—Yes. I made several experiments in order to discover the cause of the discrepancies between the amount of arsenic introduced with brewing material and the amount found in the finished beer. The following experiments were performed: *Firstly*, to show that pure yeast abstracts a material amount of arsenic from arsenical wort in the course of ordinary fermentation. Wort (without hops) obtained from a brewery contained about 0·5 parts of arsenic per 10,000,000 (about 1·280 grains per gallon). To 500 ccs. of this wort, about 2 milligrammes of pure low yeast (Carlsberg) were added, and fermentation was allowed to continue for four days. The fermentation was slow, and the fluid at the end had acquired a pleasant sweet, fruity smell. After the yeast had been separated the fluid was tested again for arsenic, only doubtful traces were found. The same experiment was repeated after the addition to the wort of arsenious acid to the extent of 20 parts to 10,000,000. The wort contained therefore 20·5 parts of arsenious acid to ten million parts of fluid. The quantities of yeast and wort were the same as in the above experiment and the fermentation was allowed to continue for the same length of time—the fermenting fluid had a pleasant but somewhat sour smell. At the end of the experiment the yeast was separated by centrifugalisation, 1·25 grammes of yeast being obtained in this way, after draining off the excess of fluid retained, so as to get the yeast in the same state as ordinary pressed yeast is, the weight of the yeast was 0·89 gramme, *i.e.*, about 450 times the amount originally introduced. The quantities of arsenic found were as follows:—

Original wort before fermentation 20·5 parts of arsenic per 10 million parts.

Fermented wort four days after, about ten parts of arsenic per 10 million parts.

Yeast before fermentation, 0.

Yeast after fermentation over 2,500 parts of arsenic per 10 million parts.

Affinity of yeast for arsenic.

This would correspond to about 1·75 grains of arsenic per pound of yeast obtained at the end of fermentation. So that starting with highly contaminated wort and pure yeast, a very large amount of arsenic is taken up by the yeast before the beer is finished. *Secondly:* Part of the arsenic found in the moist yeast is due to the presence of fluid retained between the yeast cells. To obtain an approximate idea of the amount of fluid thus retained 30 grammes of ordinary pressed yeast were washed with water, and separated again by means of the centrifuge. After this process had been repeated several times the water was allowed to drain off the separated yeast, which was then obtained in a pultaceous mass, resembling the ordinary unpressed yeast, a certain quantity of that moist yeast was weighed, allowed to dry, so as to free the cells from the excess of interstitial water, and weighed again. It was found in this way that the weight of the yeast in a state of dryness resembling that of pressed yeast, was about 5-7ths of the weight of the moist yeast. The amount of fluid retained could not, therefore account for more than a fraction of the arsenic taken up by the yeast. This was shown also in another way. 30 grammes of ordinary baker's yeast contained 0·00024 grammes of As_2O_3. 30 grammes of the same yeast after repeated washings and separation by centrifuge contained 0·00005 grammes of As_2O_3. In this case only a little more than 1-5th of the original amount of arsenic was found in the yeast after thorough washing, but as the yeast was common baker's yeast, containing many damaged or dead cells, the contents of which would be partly or entirely removed by repeated washing, the amount found at the end does not represent the whole of the cellular arsenic. This amount is, however, sufficiently large to show that the yeast cells had retained a material amount of arsenic. *Thirdly:* Even arsenical yeast may remove some arsenic from badly contaminated wort. To 100 ccs. of wort (without hops), containing 1,000 parts of As_2O_3 per 10 million, were added 2 grammes of yeast containing 80 parts of As_2O_3 per 10 million. Fermentation was allowed to continue for four days, it was very active, but the fermented fluid had a sour not very pleasant smell. At the end of this time the fermented fluid contained less than 500 parts of As_2O_3 per 10 million: the moist yeast contained over 1580 parts of As_2O_3 per 10 million. A considerable amount of arsenious acid had therefore been removed from the wort, the amount of arsenic originally present in the yeast having been insufficient to saturate the young cells produced by the old arsenical ones. *Fourthly:* Arsenical yeast yields a distinct amount of arsenic to wort which was originally free from the poison or contained only a small amount of it. To 100 ccs. of wort (without hops) containing about 0·5 As_2O_3 per 10 million, were added 2 grammes of yeast containing 80 parts of As_2O_3 per 10 million. Fermentation, allowed to continue for four days, was very active; the fermented fluid had a sweet and fruity smell. At the end of that time the fermented wort contained 0·8 part As_2O_3 per 10 million; moist yeast (considerably increased in amount) contained 28 parts As_2O_3 per 10 million. The same experiment as the above was repeated, with the result that the fermented wort contained at the end of the fermentation 1 part of arsenious acid per 10 million parts. The amount of arsenic contained in the wort had therefore increased to a material extent through the use of arsenical yeast. The same experiment was repeated with arsenical yeast which had been allowed to go bad by being kept in a bottle for several weeks. This yeast had become semi-fluid, brown in colour, and had a bad smell. It contained a large number of dead and broken up yeast cells, and many putrefactive bacteria. To 100ccs. of wort, containing 0·5 parts of As_2O_3 per 10 million were added 4 grammes of this bad fluid yeast, containing 82 parts of As_2O_3 per 10 million. Fermentation was allowed to continue for four days, at first the growth of the yeast was very slow, and the fermenting fluid had a very unpleasant putrid smell, and was very turbid (putrefactive bacteria) at the end of four days the growth of the yeast had become more normal and the smell almost pleasant, and not unlike that associated with normal fermentation. At the end of that time the fermented fluid contained about 5 parts of As_2O_3 per 10 million, the separated yeast contained about 4 parts of As_2O_3 per 10 million. *Fifthly:* In trying to obtain arsenic-free yeast in the ordinary market it became evident that it was practically impossible to obtain such an article in Manchester. The following results were obtained with samples from five different sources:—

(1)	Baker's yeast (from baker)	- 80	parts per 10 million.
(2)	,, ,, same source as 1. 26 days later	- 40	,, ,,
(3)	,, ,, "Scotch" (from importer) -	- 40	,,
(4)	,, ,, other than 1 (from baker	- 40	,, ,,
(5)	,, ,, "German" (so-called, really imported from Holland) (from grocer)	- 25	,, ,,

Bread made with one of the samples of yeast (1) was tested for arsenic. This bread was obtained from the

baker from whom the yeast had been obtained; it contained less than 0·25 parts of arsenic per 10,000,000, *i.e.*, less than 1-5600th part of a grain per lb.

5271. (*Mr. Cosmo Bonsor.*) Did you happen to analyse the beer drawn off from the yeast?—Yes. We have not pressed it, but we have washed it, and estimated the amount of arsenic found in the fluid used for washing the yeast.

5272. When the yeast comes down it contains a certain amount of beer which is practically recovered by pressing?—That would contain a large amount of arsenic.

5273. Was that beer tested separately?—Not that beer, but the fluid which we obtained by washing the yeast was tested. That was not exactly what would correspond to the beer obtained by pressing because if the yeast is kept for some time, and pressed afterwards, a number of yeast cells get broken up, and the amount of arsenic obtained under those conditions would be greatly in excess of anything we found.

5274. (*Chairman.*) Is it not dangerous to use the same yeast over and over again?—Yes, to a slight extent.

5275. The yeast increases?—Yes.

5276. The usage is to take a sufficiency of the yeast that has been already used, and use it in a fresh brew?—Yes.

5277. Does that go on indefinitely?—Yes. The yeast when it is badly contaminated and placed in wort free from arsenic, can yield to the wort a certain proportion of arsenic which is not taken up at once by the young yeast. Young yeast abstracts afterwards a large proportion of the arsenic yielded in the first instance by the old yeast, but there may still remain some arsenic which is not abstracted in that way.

5278. The use of yeast from a brewery by bakers is common, I believe?—Yes, I have heard that this is the case.

5279. Is there not a danger, therefore, of introducing arsenic into bread?—Yes. We found actually that all the bakers' yeast we could get in Manchester contained arsenic to a greater or less extent, and the bread made with that yeast also contained arsenic, but in a very small quantity. I have also examined a sample of Chinese yeast, which is not the same kind of yeast as that used here, but a kind of mould, which is generally grown on rice for the purpose of making a fermented liquor. I found it contained only a minute trace of arsenic. This was rather interesting with regard to beri-beri. It has been supposed that the rice may become contaminated with arsenic owing to the practice which the Chinese have of using arsenic rather indiscriminately, and thus become a source of arsenical poisoning. I thought that by examining a mould grown on rice in those countries if there was much arsenic in the rice, we should find it in the fungus, but we have not found much arsenic in that yeast—less than half what we have found in the best German yeast (5) we have examined.

5280. Were the quantities of arsenic you found in bread so great as to be dangerous to health?—They are extremely minute. It is difficult to estimate accurately such small quantities, but there seemed to be less than 1,5,000th part of a grain of arsenic per pound of bread, which I believe is practically negligible.

5281. So far as the specimens of bread you have examined go, there is no danger to the public health?—I do not think so, but of course I would not like to offer a very positive opinion on that point. It seems to me quite improbable that 1-5,000th part of a grain per pound can do any harm to anybody.

5282. (*Dr. Whitelegge.*) You think of the arsenic as being assimilated by the yeast cell?—I do not know whether it is actually assimilated—it is taken up by the cell.

5283. It is inside the cell?—Yes. The yeast was washed with a large quantity o fwater. The water after being separated from the yeast contained a large amount of arsenic. Then the yeast was washed a sufficient number of times to remove any trace of arsenic from between the yeast cells, and when the water was practically free from arsenic—it is almost impossible to get it absolutely free from arsenic, because some yeast cells break up one after the other it was found that a very material proportion of arsenic was retained in the thoroughly washed yeast cells.

5284. All you wish to say is, that the arsenic must be inside the cell.

5285. But you do not express any opinion whether it was in chemical combination, or present as arsenious acid inside the cell?—I would not like to say. The only thing I can say at this stage in favour of the view that it enters into combination is that its presence favoured the growth of yeast to an extraordinary extent. Yeast grows much more rapidly in an arsenical solution not containing too great an amount of arsenic, than in an ordinary solution containing no arsenic. This seems to indicate that it has some effect upon the metabolism of the yeast cell.

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5286. (*Mr. Cosmo Bonsor.*) Practically the action of fermentation reduces the amount of arsenic which gets into the wort?—To a considerable extent. More arsenic in beer if arsenical sugar used as priming.

5287. We have it in evidence that Bostock's invert sugar was used for priming, and did not go through the process of fermentation at all. If it had gone through the process of fermentation we may presume that it would not have been so harmful as it was in the way it was used?—I think so; but priming was not used in the case of all the beers in which we found arsenic.

5288. There was priming in the cheaper ales?—Yes, but we found a good deal of arsenic in the better ales, too.

5289. But not in the same quantity?—No.

5290. (*Chairman.*) In those instances where you detected arsenic in hops, you estimated it about 1-200th of a grain per pound?—Yes; that would mean, on the supposition that as much as 1 per cent. of hops was used, a minimum of 1-2000th of a grain of arsenic added by the hops to a gallon of beer. The largest amount of arsenic we found in hops was $\frac{1}{100}$ grain. Arsenic in hops.

5291. You have some experiments on the action of hops free from arsenic when boiled with arsenical wort?—Yes. I found that during the boiling of arsenical wort with hops an appreciable amount of arsenic is taken up by the hops. 500 ccs. of arsenical wort were boiled for two hours with 5 grammes of arsenic-free hops (1 part of hops to 100 parts of worts). The fluid at the end of this was filtered, being caused at the same time to pass through the hops to imitate the usual filtration of wort through hops. The amount of fluid retained by the hops at the end of this process was calculated by difference. The original weight of dry hops was 5 grammes, the weight of moist hops 23 grammes, amount of fluid retained 18 grammes. The amount of arsenic present in the wort and in the moist hops was then estimated by the modified Reinsch's process, with the following results:—Arsenic in wort filtered through hops, about 10 parts per 10 million. Arsenic in moist hops (5 grammes hops, 18 grammes wort), 21·75 parts per 10 million. The amount of arsenic removed by the hops may be calculated as follows:—Quantity of arsenic found in 23 grammes of moist hops, 0·00005 grammes; quantity of arsenic present in the 18 grammes of wort retained by the hops, 0·000018 grammes; quantity of arsenic therefore taken up by the 5 grammes of dry hops, 0·000032 grammes. On the supposition that one part of hops is used to 100 parts of wort, the amount of arsenic stopped from arsenic-free hops would be about 1-50 grain per gallon of beer.

5292. You also endeavoured to ascertain whether brewing plant might become contaminated with arsenic?—Yes; I performed the following experiments in this direction. In view of the extensive use of copper utensils in brewing, I endeavoured to see whether arsenic would be deposited on the copper during the boiling of arsenical hops in wort. Arsenious acid was added to fresh wort, so as to bring the total amount of arsenic present to 20·5 parts per 10,000,000, *i.e.*, a little over 1·7 gramme per gallon; 5 grammes of hops were added, as well as two pieces of copper (no hydrochloric acid). The mixture was boiled for two hours. At the end of that time the copper was found to be very slightly dulled, but no sublimate of arsenic could be obtained from it. It is therefore evident that no appreciable precipitation of arsenic similar to that which occurs during the application of Reinsch's process takes place whilst the wort is boiled in copper vessels. Any arsenic which may be found in the deposit of coagulated matter is independent of the action of copper. In brewery plant

5293. That shows that none of the arsenic settles on the copper in the regular brewing process?—Yes.

5294. Have you anything to say on the storage of arsenic in the wood of the fermenting tun?—A piece of oak measuring 2 x 2 x 1 inch was immersed in 500 ccs. of wort, to which 5 grammes of yeast had been added. The wort contained 20·5 parts of arsenic per 10,000,000, the yeast 80 parts per 10 million. At the end of four days' fermentation it was found that the fluid had not penetrated very deeply into the wood. After wash

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ing this piece of wood with distilled water, the piece was divided into fine splinters, suspended in 200 ccs. of water, and tested in the usual way. A sublimate of arsenic corresponding to less than $\frac{1}{100000}$ was obtained. This experiment shows that some arsenic is retained by the wood, but does not indicate that wood has the power of abstracting arsenic from the wort. There was in the solution a large amount of yeast; the wood was new, and was not easily penetrated by the wort, so that the experiment is not conclusive. In a second set of experiments two blocks of oak similar to the block used in the first experiment, and weighing respectively A 50·90 grammes, and B 52·5 grammes, after being rapidly immersed in water and dried with filter paper, were used. These blocks were kept immersed for four days in fermenting wort containing 100 parts of arsenic per 10,000,000. At the end of that time, both blocks were removed, and rapidly washed to remove the yeast and wort adhering to their surface. They were then dried with filter paper and weighed. Block A weighed 58·16 grammes, having retained 7·26 grammes of wort, block B weighed 60·1 grammes, having retained 7·6 grammes of fluid. Block A was then divided into fine splinters, suspended in 200 cc. of water, and the mixture tested for arsenic. The proportion of arsenic contained in the 7·26 grammes of fluid retained was found to be equal to 138 parts in 10,000,000; *i.e.*, 38 parts over the amount originally present in the wort. The wood seemed therefore to have had some power of storing arsenic. Block B was placed in 120 cc. of pure lager beer free from arsenic, in which it was allowed to remain for 24 hours, the temperature being 37°C. At the end of that time the fluid was tested for arsenic, which was found to be present in the proportion of 2 parts to 10,000,000. A material amount of arsenic stored up in the wood had therefore been yielded to the beer.

5295. In the wood used in the brewery arsenic goes on accumulating?—Yes. The reason why this part of the investigation seemed necessary was, that we had often found the first beer brewed from hops and malt alone in breweries where invert sugars had been used previously, contained more arsenic than we expected to find on account of the hops and malt alone, and this investigation into the brewing plant became necessary in order to find why there was a discrepancy between these results.

5296. (*Mr. Cosmo Bonsor.*) In that particular instance you have mentioned, I suppose they changed their yeast entirely, and got uncontaminated yeast for the following brewing?—I do not know.

5297. If the yeast were used it would account for carrying on the arsenic for a considerable number of years?—Not exactly. If yeast is used for two or three brews, the wort being practically pure, the yeast will purify itself very rapidly, the young yeast taking up the arsenic brought in by the old yeast, and after a short time the amount of arsenic present in the yeast would become infinitesimal, and there could not be any transference of arsenic to the beer.

5298. (*Dr. Whitelegge.*) Can you say whether the plant had been cleansed in the usual way for this examination?—I think it had been thoroughly washed. The pieces of wood I experimented with were also washed before they were put into beer to see whether any arsenic would be yielded.

5299. (*Mr. Cosmo Bonsor.*) Would scalding destroy arsenic in a wooden vessel?—I do not think so. It would take a long time to remove all the arsenic which had collected in the wood of fermenting tuns and barrels. I think the only way would be a long soaking, very prolonged soaking, especially with some fluid containing a certain amount of alkali, soda, or potash.

No evidence of formation of arseniuretted hydrogen in contaminated beer.

5300. (*Chairman.*) I think you have some observations on the possible presence of arseniuretted hydrogen in beer?—Yes. Savitsch, Johansohn, and Schultze have shown that arsenic does not necessarily interfere with the growth of yeast, but may modify its actions. Schultze states that a proportion of arsenic equal to 1-40,000 augments the activity of yeast. Johansohn finds that when the amount of arsenic is increased, the growth of yeast is interfered with and ultimately arrested. A quantity of arsenic sufficient to interfere with yeast is, however, insufficient to stop the growth of many putrefactive bacteria and moulds. These organisms, by assimilating the oxygen and carbon of organic compounds, set free a certain amount of nascent hydrogen, which produces some arseniuretted hydrogen at the expense of arsenious acid. That is the theory offered by Johansohn. It might therefore be reasonable to assume that arseniuretted hydrogen, which is one of the most highly poisonous compounds of arsenic, was present in small quantities in beer brewed from arsenical glucose. There was, however, no evidence of the presence of this gas in the beers examined. On the other hand it seemed improbable that any amount of this gas should be retained in a fluid kept in open vessels and saturated with carbonic acid constantly evolved. No evidence of the presence of this gas was obtained when the Marsh test was applied to untreated beer, small traces might have, however, escaped detection. To clear this point I devised the following experiment: 300cc. of wort containing 200 parts of arsenic per 10,000,000 parts, with 3 grammes of arsenical yeast containing 66 parts of arsenic per 10,000,000 were allowed to ferment in a closed flask—6,000cc. of air were made to pass at intervals through that flask, the air removed from the flask being made to bubble slowly through neutral silver nitrate solution. At the end of four days there was only very slight evidence of reduction of silver, which was most marked in the last bulb (exposed to light). This solution was tested for arsenic with negative results. Therefore, I think the question of arseniuretted hydrogen can be entirely dismissed.

No evi... of selen... in Nitr... acid.

5301. Have you found any evidence of the presence of selenium in the beers you have examined?—No. Selenium, like arsenic, is very widely distributed, is frequently present in pyrites from which sulphuric acid is prepared, and is specially abundant in pyrites and other minerals coming from certain countries, *e.g.* Norway and Hartz Mountains. It was therefore possible that minute traces of selenium might be present in impure sulphuric acid, but it was certainly not present in any appreciable quantity in our sample of the sulphuric acid used by Messrs. Bostock and Company. No red precipitate or coloration was produced by sulphurous acid in the two samples of sulphuric acid which we obtained from those manufacturers. To ascertain whether the test we had applied was sufficiently delicate, I obtained some selenium and some selenic acid. A solution of selenium in fuming sulphuric acid was prepared and diluted with H_2SO_4. One part of selenium in 10,000 parts of pure sulphuric acid had a very distinct pale greenish-yellow colour. On floating a solution of stannous chloride on the surface of the acid a brownish-red coloration and precipitate were produced. On diluting the 1/10,000 acid solution with some water a reddish-yellow coloration and cloudiness were produced. The arsenical brown oil of vitriol obtained at the sugar factory on being diluted became clearer, and assumed a pale greenish tint (due to the presence of iron). Stannous chloride produced no red line or precipitate. The same results were obtained with $SnCl_2$ after the addition of selenic acid to pure sulphuric acid. 1cc. of a 1 in 400 solution of selenium in sulphuric acid, after being neutralised with ammonia, was tested by Reinsch's method. A soot-black precipitate was produced on the copper; this could not be volatilised like arsenic in the sublimation tube, and remained unaffected. From none of the samples of beer or other material examined in my laboratory had a similar deposit been obtained. This deposit was soluble in fuming sulphuric acid giving a green solution, which on being diluted with water yielded a reddish precipitate. Considering the facts that the sulphuric acid contained from 1·4 to over 2 per cent. of arsenious acid, and that no trace of selenium was revealed by tests which showed easily the presence of 0·01 per cent. of selenium, I think that selenium cannot have had any appreciable share in the production of the outbreak.

5302. (*Chairman.*) The black deposit produced by selenium was not volatile?—No. It would be volatile under the influence of sufficient heat, but not like arsenic in the sublimation tube, when the tube is not overheated. We got absolutely no sublimate, and the colour of the copper was very different from what we obtained with arsenical products. In addition to that, the deposit could be dissolved from the surface of the copper with fuming sulphuric acid, giving clearly the green colour of a solution of selenium in sulphuric acid, and this colour gave place at once to the red discoloration which is produced by dilution with water. So that it would be practically impossible to overlook the presence of material quantities of selenium. On diluting the H_2SO_4 for the purpose of applying various tests, one would get the red precipitate on the addition of water.

5303. (*Sir William Church.*) Very little is known of the action of selenium or its salts upon animals?—I know nothing from personal experience. Of course if selenium had been present it would have been worth while enquiring into its action in connection with the present enquiry, but as with a solution of one in

100,000 I got reactions which could be quite easily recognised, and no such reaction was observed. I think the theory that selenium was a material factor in the production of the epidemic can be put aside.

5304. I asked you the question because it has been put to us by one witness that he was not satisfied from the description of effects of arsenic that the arsenic could account for it, and he thought it might be due to some other matter being present, and selenium suggested itself, because selenium in animals produces marked wasting?—I shall be able to show that the amount of arsenic present in the beer which we have examined is quite sufficient to produce all the symptoms which have been observed in the epidemic.

5305. I should also like to know if you have any opinion whether sufficient is as yet known of the action of selenium on man to draw any inference?—I should say I know so little that it is impossible for me to say anything.

5306. Have you formed an opinion as to what dose of arsenic administered with beer or food may be considered so small that it may be safely disregarded?—Arsenic is so widely distributed in minute quantities in nature that the finding of small quantities of it would have been of very slight assistance to the public authorities unless one was in a position to state at the same time that the quantity found was sufficient to account for the production of disease. In the absence of authoritative statements on the subject, it seemed to me that the only guide one could take was the experience of the therapeutist. It is generally believed that it is almost useless to administer for medicinal purposes less than 1-28th grain of arsenious acid in the day (this dose corresponds to about two minims of Fowler's solution taken twice a day). Such a dose may be taken for a considerable time by most people without any bad effects, but allowing for idiosyncrasy and disease, it would not be advisable to take such a quantity of arsenious acid daily, and more or less continuously, without knowing it and without medical advice. About smaller doses there might be differences of opinion. I felt, therefore, justified, on the assumption that most beer drinkers consumed half-a-gallon of beer daily, that whenever a beer contained as much as or more than 1-28th grain of arsenic in half-a-gallon, that beer should be condemned. Since then I have learnt that one gallon is not an unusual allowance, so that I have had to lower the limit which I had at first adopted. As I had found that it is comparatively easy to estimate an amount of arsenic in beer equal to one part in 10,000,000, and as 1-28th grain per gallon corresponds to one part in 1,960,000 parts, there is no difficulty in detecting an amount of arsenic which is injurious in this sense. Any prosecution based on the finding of such a quantity would be justified on the ground of sound experience. With regard to somewhat larger, though still small, medicinal doses, there are certain statements which leave very little doubt as to the dangers connected with those doses. Thus Lachèse (Annales d'Hygiene, Series I., xvii., 1834) states that six milligrammes of arsenic (about 1-11th grain) produce decided though not serious symptoms, and that doses of 10 to 30 milligrammes (1-6th to under ½ grain) have been toxic though not lethal. Jaccoud (Traité de Pathologie Interne II., p. 1,002, 1877) speaks of the danger of a continuous administration of doses of arsenic ranging from 1-11th to 1-6th grain daily. He says that such doses may be taken for weeks and sometimes months without bad effects, and often with benefit, but that a limit of tolerance is frequently indicated by symptoms of chronic poisoning, beginning insidiously, and getting rapidly worse unless the drug is stopped. This he attributes to a saturation of the tissues or what we would term now cumulative action. Maerck gives in his atlas of Diseases of the Skin (English Edition, p. 136, 1900) a picture of arsenical hyperchromatosis of the skin (arsenical pigmentation) taken from a patient who in three months and a-half had taken 900 drops of Fowler's solution. The patient had been treated for four weeks in July and for six weeks from late in August into October. Both times the treatment had begun with five drops of Fowler's solution daily, and reached in the first course of treatment 20 drops, and in the second period 25 drops daily. This patient had taken in the course of 100 or 105 days about four grains of arsenious acid (in the form of arsenite of potash), making an average daily dose of about 1-25th grain daily, the actual extreme doses taken daily ranging from ¼th grain to 1-40th grain. (The same author mentions other cases in which 3¼ grains and 1⅞ grains had been sufficient to produce pigmentation.) The symptoms observed in that patient having been typical of chronic arsenical poisoning, it is evident that the arsenical beer drunk in Salford contained more than enough to account for the symptoms of arsenical poisoning. Of the beer containing 1½ grain of arsenious acid per gallon, half a glass taken daily would have been sufficient; of the beer containing ¼ grain to ⅛ less than one pint; of the other beers from half to one gallon, or a little over, would have supplied enough arsenic. The few cases of chronic poisoning I have mentioned do not at all exhaust the list of cases in which one could find evidence of the action of an arsenious acid or arsenites in doses which were not larger than those present in the beer. I have simply given a few very typical cases, which I had no difficulty in finding, but I have no doubt more cases could be found.

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5307. Then in your opinion there was quite enough of the poison to account for the symptoms in even moderate drinkers?—Yes. I think it is a fortunate thing that all are not equally susceptible to the action of arsenic, and that many persons can take larger doses of the drug without being injuriously affected by it. In the case recorded by Dr. Heaton in the "Lancet" (26th January, 1901), 5½ grains of arsenious acid, 10⅜ grains of sodium cacodylate, 105 grains of arsenate of soda, were all taken by a patient without bad effects in the course of 271 days, including intervals amounting to 58 days. The maximum dose administered at one time being 2⅜ grains of sodium arsenate, which in toxic power would be equivalent to about 1½ grain of arsenious acid. These facts seem sufficient to account on the one hand for the occurrence of a number of instances of arsenical poisoning in moderate drinkers, and on the other hand for the escape of a number of other consumers. The same facts make it unnecessary to assume the presence in beer of any substance more poisonous than arsenious acid or arsenites.

Individual susceptibility to arsenic.

5308. In what you have been saying you refer to quantities of arsenic which have produced distinct effects easily recognisable by medical men as due to arsenic. Is it possible that doses of arsenic smaller than those which have been known to produce distinct effects might, when taken continuously for a considerable time, produce illness which would not obviously be attributed to arsenic?—I think it is quite possible, and it is obvious that if there is any doubt on that point, the presence of any appreciable quantity of arsenic is objectionable. We have found that certain samples of beer were quite free from appreciable traces of arsenic: it might therefore be urged that any beer containing a trace of arsenic should be condemned. Our investigation has shown, however, that small traces of arsenic are so difficult to avoid, that to exclude arsenic entirely from our diet would probably be an impossibility. It is therefore necessary for practical purposes to fix a certain maximum limit of the amount of arsenic which may be tolerated in beer. This is a matter of some difficulty, for we have absolutely no record of observations upon which such a limit could be based. It will not be possible to fix such a limit otherwise than in an arbitrary fashion, until a large number of articles of food and drink, which have been found to be wholesome by the experience of several generations, have been analysed, and the amount of arsenic which they may contain has been determined. We have already some data of this kind. We know that beer brewed from malt and hops only has been drunk without causing marked outbreaks of disease. We also know that the amount of arsenic present in malt dried in old-fashioned kilns may be large enough to account for about 1-50th of a grain of arsenic in a gallon of beer, and in exceptional (probably very rare) cases for as much as 1-30th or possibly 1-25th of a grain per gallon. Old kilns and bad fuel have undoubtedly been used for a long time, so that beer containing from 1-30th to 1-50th of a grain of arsenic must have been drunk in large quantities. It is equally clear that beer brewed in the Northern Counties must have usually contained from 1-300th to 1-100th of a grain of arsenic per gallon. There has not, however, been usually any excessive mortality, recognised as being connected with beer drinking. There are, however, certain lesions usually attributed to alcohol and which occur in beer drinkers; among these I may mention alcoholic neuritis and certain lesions of the liver. Dr. Reynolds, as far back as 1890, attracted attention to the fact that so-called alcoholic peripheral neuritis was not necessarily due to alcohol, since it seemed special to beer drinkers, and did not affect to any marked extent pure spirit drinkers.

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Cirrhosis of liver and arsenic.

I have myself taught for many years the view that cirrhosis of the liver, which is usually indiscriminately attributed to alcohol, was probably in most cases due to the action of various poisons, bacterial and others, acting independently of or in conjunction with alcohol. Many of those protoplasmic poisons, when acting in large and fatal doses, cause a rapid degeneration of cells which have become highly specialised for certain functional purposes. The same poisons when acting in smaller doses produce also irritation, the effects of which are most noticeable in the connective tissue supporting the differentiated cells and in the cutaneous epithelium; this irritation leads to an increase of fibrous tissue, or, in other words, cirrhosis, and to various cutaneous lesions. Arsenic acts in this way comparatively rapidly. Alcohol, on the other hand, is a much less powerful poison, and acts very slowly, that is, in the usual doses taken by an ordinary drinker. In my view alcohol cannot, by its direct action, be the essential cause of the increase of connective tissue found in the liver of a certain proportion of beer drinkers, more especially when there is some evidence to show that such an increase has taken place within a comparatively short interval of time. On these grounds it is therefore reasonable to look with suspicion upon the presence of even small quantities of arsenic in beer (as well as in other foods or drinks). With the object of finding how much arsenic might be taken daily without apparent bad effects I have collected analyses of some arsenical mineral waters.

Arsenic in Vichy water.

5309. These analyses are in a table?—Yes. They are given in table 13(p.357). Of the waters in that table, the Vichy is one drunk by a considerable number of people (the springs are visited by about 40,000 people annually, and a large quantity of the water is exported). According to Bouquet's analyses the water from the various springs contains from 0·002 to 0·003 of arsenate of soda per 1,000, *i.e.*, from 20 to 30 parts per 10,000,000. So that when the maximum dose is taken a patient may be taking as much as ·1-20th grain of arsenate of soda daily. It must be remembered that arsenate of soda is much less poisonous than arsenites or arsenious acid (according to Rouyer, in dogs the toxic dose of arsenite of potash and of arsenious acid is 0·06 gramme per kilogramme, the toxic dose of arsenate of soda is 0·15 gramme per kilo). During a course of Vichy waters a patient may take a daily dose of arsenic equivalent to quantities of arsenious acid ranging between 1-224 grain and 1-45 grain, with benefit. It must be remembered, however, that some patients do not tolerate this treatment quite well, but it is impossible to say whether the intolerance is due to arsenic or not: the subject may be worth investigation. Considering the large number of people who have taken these waters without any symptoms of arsenical poisoning having been detected, and frequently with benefit, it is probable that a quantity of 1-50th grain of arsenic per gallon of beer is harmless, provided arsenic is not present in a form more poisonous than arsenious acid. It would appear therefore that when beer, sound otherwise, does not contain more than 1-100th grain of arsenic per gallon, in the form of arsenious acid or of an arsenite, it is probably a quite safe drink.

5310. Do you call alcohol a poison, taken in the quantity which would be taken by a moderate drinker?—No, but it does seem when taken in large doses to interfere with nutrition. I have animals just now which are taking various alcoholic and arsenical drinks, and when the amount of alcohol is large, it seems to interfere with their nutrition, nearly as much as the arsenic—in fact more.

Toxic effect of administration of arsenic and alcohol together,

5311. But in small and moderate doses may arsenic be regarded as a food?—It can be considered as a food, but not the best kind of food. I have made a number of experiments to estimate whether the toxic power of arsenical beer was not greater than that of solution of arsenious acid in water. In order to find out whether the presence of arsenic in beer gave rise to specially noxious compounds, or whether the association of arsenic and alcohol was particularly detrimental to health, I have also made some other experiments which have extended over two months, and have already yielded clear results. The experiments are still going on, and if I might be allowed to do so, I should like to complete my statement by submitting to the Commission additional facts in the next month or two.

(*Chairman.*) We shall be very pleased to receive them.

to rodents.

(*Witness.*) Several rats, placed under absolutely identical conditions, and fed exactly in the same way, the amount of food being directly in proportion with their body weight, were given daily definite quantities of the following fluids:—(1) Arsenical beer, with a little alcohol (under 5 per cent.), the daily dose being equal to what over one gallon of beer would be to a man 140lbs. in weight; (2) arsenical beer with little alcohol, in daily doses corresponding to 2 gallons; (3) solution of arsenious acid in water varying in strength from 1-14 grain to 1-7 grain per gallon, quantity administered corresponding to 1 gallon; (4) solution of arsenious acid of the strength of 1-7 to 7 grains per gallon, quantity given corresponding to 1 gallon; (5) bitter beer containing 10 per cent. alcohol, to which 7 grains of arsenious acid had been added per gallon, the quantity administered corresponding to over 1 gallon; (6) bitter beer containing 10 per cent. alcohol, without arsenic, the quantity administered corresponding to over 1 gallon; (7) beer from which alcohol had been driven off by boiling, and to which arsenious acid had been added in the proportion of 7 grains per gallon; (8) lager, Munich beer, free from arsenic, the quantity administered corresponding to about two gallons daily. I have found that so long as the amount of arsenic in beer did not exceed ½ grain per gallon, the animals thrived well, and increased more rapidly in weight than those taking watery solutions of arsenious acid, even when the quantity of fluid administered reached 17 per cent. of the body weight. This was true only so long as the amount of solid food was large. By reducing the amount of food to 1-30th of the weight of the animal, a very rapid loss of weight was produced which was much more marked in animals taking arsenic than in those which did not. Rats seemed to take the beer freely. They drank the beer so long as it did not contain a large amount of arsenic, but when the quantity of arsenic reached 7 grains per gallon, which is very much in excess of anything contained in any beer we have examined, they left usually about an eighth or a tenth of the beer given daily. They also took water readily enough, even when it contained arsenic, but they took arsenical beer very much more readily than arsenic and water. (*A chart of the experiments was exhibited by the witness to the Commission.*) When the amount of food diminished, the animal taking arsenic suffered from rapid loss of weight, which was not observed in an animal not taking arsenic. So that a small dose of arsenic had a very much more serious effect on an animal not taking proper food, than on an animal taking a sufficient amount of food. Alcohol given in large quantities produced somewhat similar effects but less rapidly. From this I came to the conclusion that probably those who fell victims to the action of arsenic were mostly those who were ill-fed and diseased, and that the majority of those who were well fed might take a very considerable amount of arsenic without feeling any bad effects.

Amount of food taken influences toxic effects of arsenic.

5312. (*Mr. Cosmo Bonsor.*) That is the reason why women suffer so much more than men probably?—Yes, I think that has a great deal to do with it.

5313. (*Chairman.*) You think then that special conditions favour the action of arsenic?—These experiments so far show that small doses of arsenic act very much more powerfully on ill-fed individuals than on well-fed individuals. The post-mortem examinations of fatal cases also show that in a large proportion of those cases some disease was present which must have weakened the resistance of the tissues. Many of the cases were tuberculous. Dr. Moore, assistant lecturer in pathology at Owens College, who has made many post-mortem examinations of victims of arsenical poisoning at the Crumpsall Hospital, and at the Royal Infirmary, has reported to me that he has found tuberculous lesions in nearly all of them. Alcohol when taken in large quantities also interferes with nutrition; this was well shown in my experiments. These facts seem to explain why so many among the poor have fallen victims of this arsenical contamination; though some accurate statistics would be necessary to show that this special incidence is a real, and not an apparent one only. The importance of suitable feeding, and of resistance of the tissues explains also why women have been more liable to the poison than men. I have had opportunity to observe and to hear that among the poorer classes women have frequently a very unsatisfactory diet, composed in great part of bread, farinaceous foods, butter, or some substitute, etc., and tea. The male worker on the contrary considers good and substantial feeding a necessity. Women are also exposed to the weakening influence of abnor- and menstruation, to various troubles at the menopause, and occasional pregnancies. These influences are

sources of weakness special to women. It may also be supposed that the more active occupations of men favour the elimination of arsenic by the skin, and by other excretory organs. This last explanation, however, would not be in itself sufficient, for arsenic is usually eliminated rapidly by various glands, and in the case of women Brouardel and Pouchet have shown that so much arsenic can be secreted by the mammary gland that a suckling child may give clear evidence of arsenical poisoning, and even succumb when the mother has taken a large amount of arsenic. The very considerable elimination of arsenic by the skin and its accumulation in the hair, demonstrated by the same authors, and regarding which Professor Dixon Mann has made interesting observations, does not seem to be necessarily determined by exercise. It will be noticed that the first effects of even large doses of arsenic in a well-fed animal is an increase in weight; the instability of this state is, however, shown by the great and sudden fall following diminution of food. Judging by the notices appearing in the newspapers of deaths attributed to arsenical poisoning, I believe that most of the fatal cases before the end of 1900 occurred in women, very few man being affected. Since the 1st of January the proportion of men has considerably increased; this seems to show that the greater mortality among women in the early part of the outbreak was due to their succumbing more rapidly than men, and not necessarily that they were more addicted to drink than men are. More satisfactory statistics than those available to me will, however, be necessary before this explanation can be considered well-founded. The statistics collected by Dr. Tattersall show that the special liability of women was most marked between the ages of 40 to 50, *i.e.*, about the critical time of life. This supports also the view that women are specially liable on account of want of resistance. It may, however, be also urged that intemperance is more frequent at that time of life. I think, however, that the greater fatality observed in women must have been chiefly due to malnutrition, various deteriorating influences inherent to their sex, and to their sedentary habits, and that generally speaking disease and other debilitating influences have been most important factors in determining the fatal termination of those cases of poisoning which have ended in death.

5314. Can you tell us anything with regard to arsenic found in the bodies of beer drinkers?—A case I may mention is that of a woman aged 44, who was admitted to Manchester Workhouse Infirmary on October 12th, 1900, and who died at the end of February, 1901. The peripheral neuritis was not severe, but progressive. There was no pigmentation. There was pleural effusion, with extreme wasting, contractures, and incontinence. The thyroid gland contained somewhat less than eight parts per 10 millions; the spleen less than three parts per 10 millions, and the bodies of the vertebræ about 3·5 to 4 parts per 100 million. Calculated on the basis of the amount of arsenic in the spleen, the total amount of arsenic retained in the body of a person weighing 140lbs. would have been about 1-10th grain. As the spleen is not known to have the power to retain more arsenic than have other tissues, the quantity actually present in the whole body would probably be more than 1-10th grain. Another patient, a male, aged 50, was admitted to Crumpsall on November 3rd, 1900. His illness was said to have begun about the middle of September. There was cough, dyspnœa, and œdema. On admission there was marked peripheral neuritis, enlarged liver, and deep general pigmentation. There was also pneumonia or tuberculosis, and he died on March 1st. There was less than five parts per 10 millions in the thyroid gland. Two other cases which had been respectively three months and 15 days in hospital showed either no trace or doubtful traces of arsenic in the organs examined, in those cases the thyroid body did not appear to contain more arsenic than other organs. These examinations were made specially with the object of finding whether the thyroid body had a special power of storing up arsenic, and also how long arsenic might be retained in the tissues after the use of arsenical beer had been stopped. As far as was known, the patients were not taking any arsenic whilst in hospital. The presence of arsenic in the skin, liver, and other organs of arsenical beer drinkers was being investigated by Professor Dixon Mann, and did not form the object of any enquiry on my part. I am indebted to Dr. Reynolds for facilities to obtain information about his cases, and to Dr. Moore and Dr. Muir for the collection of material and facts which I required.

5315. You have some general results of autopsies of fatal cases of arsenical poisoning?—I have a letter from Dr. Craven Moore giving some of the results of autopsies on cases of arsenical beer poisoning. Dr. Craven Moore states that typical periaxial degeneration of the peripheral nerves, varying in degree, has been found in the twelve cases so far investigated by him, and that the liver in many of the cases presented irregularly-distributed congestion, degeneration, and varying degrees of cirrhosis. He also states that the skin in many of the cases was pigmented in various degrees. *Prof. S. Delépine.* 30 Mar. 1901.

5316. With regard to the presence of arsenic in food and preservatives, have you made any investigations into that matter?—I have asked Dr. Coutts to investigate some articles of food which had been sent to me, and to determine the presence or absence of arsenic and the sources of poison when present. The amount of arsenic found in several substances which are used as preservatives has important bearings upon the present inquiry, and I put in Table II. (Appendix No. 12) the facts which he has given me. Arsenic in borax.

5317. (*Sir William Church.*) What is the probable source of the arsenic in shrimps?—Possibly some borax used as a preservative. We have not been able to obtain the actual preservatives used, but Dr. Coutts is pursuing this investigation, and has already examined many of the substances in common use for preserving articles of food, and has found that several of these contained very material proportions of arsenic, as one naturally expected they would. In borax got from a grocer as much as 1-28th to 1-23rd of a grain of arsenic per pound was found.

5318. (*Chairman.*) What special measures in connection with arsenic in beer appear to you to be indicated by the present outbreak?—Firstly, that sulphuric acid manufacturers should send with each invoice of sulphuric acid an approximate statement of the amount of arsenic contained in it, the amount of arsenic being also stated on the label, or its absence guaranteed. Secondly, that glucose or invert sugar manufacturers, or any other manufacturers using sulphuric acid in the preparation of food, should use only sulphuric acid free from arsenic in the preparation of these food articles, any infringement being liable to severe penalty. Thirdly, that maltsters should guarantee their malt to be free from appreciable amounts of arsenic. Fourthly, that brewers should be made responsible for the purity of the beer manufactured by them, and make it a practice to have their brewing material regularly analysed for arsenic in the course of the analyses to which these materials are submitted for other purposes. That any new kind of material introduced in brewing should be submitted to a complete quantitative analysis by chemists of the highest standing before the use of such a substance is allowed. Fifthly, that retailers should not be permitted to add any substance to the beer they sell (other than such material as may be supplied to them by the brewer from whom the beer has been obtained); any addition being considered fraudulent. Sixthly, that some reliable method of analysis should be recognised officially by which the detection of any amount of arsenic equal to or exceeding 1-100th grain (or 1-200th grain) per gallon may be easily made. Seventhly, that any beer in which the presence of arsenic had been revealed by this method should be condemned as unfit for consumption. Eighthly, that the importance of not using chemicals containing arsenic (sulphuric acid, hydrochloric acid, carbonate of soda) for the purpose of cleaning bottles, etc., should be made generally known, as well as the necessity of very thorough washing with water after the use of any chemical substance for that purpose. Amount of arsenic in sulphuric acid should be declared. Brewing ingredients should be tested. Standard test for arsenic in beer required to enable condemnation.

5319. Do you suggest any machinery for carrying out the suggestions you have made?—Of course, I am not an expert in public health administration, or in legal matters, and any suggestions I may make, I make with a certain amount of hesitation. Some Government control over the manufacture of artificial articles of food seems to me to be necessary. This might be obtained by a system of registration and licence, no licence being given by the Government through the local sanitary authorities to would-be manufacturers who personally or through a responsible agent did not show a reasonable knowledge of the processes they intended using, and of their dangers to public health. Secondly, the public health authorities (central or local) might issue schedules indicating the substances which are liable to affect public health, the tests necessary to discover them and recognised by th›

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authorities, the methods and tests to be employed being described minutely. Such schedules would naturally be liable to periodical revision.

5320. (*Mr. Cosmo Bonsor.*) By the Government you probably meant the local authority?—The Local Government Board through the local health authorities.

5321. How far would you carry that. It occurs to me that if it was carried very far it might prevent a retailing druggist from selling a summer drink to people, a thing which is done a great deal?—I am not an administrator, and this is a detail upon which men acquainted with the administration of the law could advise better than I could. In the case of Bostock's, for instance, nobody could accuse them of having been criminal in intention, but, at the same time, they were absolutely without any knowledge of the importance of securing sulphuric acid free from arsenic, went on using it for some considerable length of time, and might have done a great deal more damage if their mistake had remained undiscovered.

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5322. Do you think that all manufacturers should have a knowledge of chemistry?—No, but if the manufacturer knew chemistry, he might be expected to know the processes he intends using, if he only finds the capital he should employ a competent chemist or technical expert who should be able to give a guarantee to the Local Government Board that the processes which are used under his direction are of such a nature that there is no possibility of the introduction of poison into the food articles he manufactures.

5323. (*Sir William Church.*) Perhaps you would like these only to be considered as suggestions?—Only as suggestions.

Mr. William Marshall, Public Analyst to the Borough of Hyde, called; and Examined.

Mr. W. Marshall.

5324. (*Chairman.*) You wish to make a statement as to some information we were wishing to obtain?—Yes. As Public Analyst for Hyde I was present at the Rochdale case, which was mentioned yesterday. The case was brought by the County Authorities; 1-5th of a grain of arsenic was said to be present. The case was dismissed not on the question of the arsenic at all, but on a technical point, viz., the division of the sample. The County analyst found 1-5th of a grain, Somerset House found 1-30th of a grain, I found 1-30th of a grain, another analyst found 1-15th of a grain, and another 1-40th of a grain; but the 1-40th of a grain was As, elementary arsenic, whereas in As_2O_5 it would have been 1-30th.

Prosecution at Rochdale.

5325. (*Chairman.*) That reduces the discrepancy very much from what was put before us yesterday?—Yes. Somerset House found 1-50th of a grain As_2O_5.

5326. (*Dr. Whitelegge.*) There was a further result of 1-5th?—The county analyst gave the amount as 1-5th and the prosecution was taken on the 1-5th.

Mr. W. Marsh

5327. Then the discrepancy remains?—Yes; the case was dismissed on the question of the division of the sample, and the magistrates gave no opinion about the arsenic at all.

Reason fo magistrat decision.

5328. (*Chairman.*) The question of the credibility of the tests for arsenic did not come before the magistrates?—All the evidence was taken on the method of testing, but they decided the point on the division of the sample. The county analyst used Berzelius's method, but I do not know what method the Somerset House authorities used. I used a modified form of the Marsh test.

Mr. Henry Spencer, called; and Examined.

Mr. H. Spencer.

5329. (*Chairman.*) You are collector of Inland Revenue for Manchester collection?—That is so.

5330. You have had occasion to visit various breweries officially in Manchester?—I have.

Duties of Officers of Excise in breweries.

5331. Will you let the Commission have the benefit of any information you can give with respect to the subject of our enquiry?—The Commissioners of Inland Revenue desire me to appear before you to give evidence touching your inquiry. The object sought by the proposed evidence is, I believe, to assist the Commission to a clear understanding of the nature of that part of the ordinary duties of officers of Inland Revenue which is connected with surveying breweries. It will be my endeavour to illustrate the character and extent of the supervision exercised by the officers at breweries by referring to Inland Revenue books of account relating to two breweries selected for the purpose from forty breweries situate in Manchester collection. As the illustration of this supervision proceeds the stages will be indicated by which control is maintained, with the view of safeguarding the Revenue. The importance of this control is at once apparent from the consideration that the beer manufactured in the United Kingdom contributes, in round figures, £1,000,000 per month to the Imperial Exchequer. It is desirable at the outset to emphasise the fact that the business of a Revenue official at a brewery is not so much to impose any restriction upon the nature, extent, and proportions of materials used in making beer as to see to it that the beer duty is correctly levied. To secure this object the officer's visits to the brewery are timed to observe and take note of certain operations and to check the traders' accounts at important stages of the manufacture. The brewer enjoys the maximum of freedom in the selection and manipulation of his brewing materials, and none of his vessels or stores are placed under Revenue lock as in the case of distilleries. The brewer must, however, conform to certain regulations in order that the officer may be able to follow the course of brewing—viz., he must give 24 hours' notice of his intention to mash malt or corn and to dissolve sugar, and the quantity or weight, and a description of the materials to be used must be entered in a brewing book provided by the Revenue authorities for the purpose, at least two hours before the said materials are timed to be used. That is the brewing book to which I refer. (*Book shown.*) I thought perhaps it would be interesting to observe the instructions given to brewers and to note the method of entering their materials, and so forth.

Supervision for revenue purposes.

Mr. H. Spe

5332. (*Mr. Cosmo Bonsor.*) I presume these instructions are absolutely in accordance with the 1880 Act?—Yes, and the amending Acts, a list of which is given on the first page. It is also required that all the worts must be removed in the prescribed order of brewing from vessel to vessel, and be finally placed into collecting or fermenting vessels, and must remain there until the officer has taken an account, or until after the expiration of 12 hours. The brewer must also enter into the aforesaid brewing book an account of the worts collected for Revenue charge. This account must include the whole of the worts produced from the entered brewing, and must show the dip of the gauged vessel (in order that the bulk quantity may be ascertained) and the original gravity of the worts—that is, the true gravity before fermentation sets in. As soon as his other duties permit, the officer checks this account, and day by day so long as the beer remains in the fermenting vessels he satisfies himself that it is not fraudulently disturbed. The brewer is practically at liberty to remove the beer from the fermenting vessel as soon as he pleases after the Revenue account has been taken by the officer. From the fermenting vessel the beer is usually run down into the cellar, where no further Revenue account is obtained of the beer unless as a check upon priming operations or should there be any reason to suspect fraud. At many breweries sugar solution—that is, sugar dissolved in water to which no yeast has been added—is prepared at a gravity not exceeding 1,150 degrees to be used as priming. Priming is usually added to beer in casks, but also may be and frequently is added to beer in the racking vessels. From these racking vessels the beer when well mixed with the priming is racked off into casks. Under regulations a quantity of sugar solution may be added to beer, not to exceed half a gallon of the solution to 36 gallons of beer, or if added to quantities of beer in bulk in racking vessels 1½ per cent. of solution may be used. In practice the quantity of solution added to the finished beer varies

Amount priming permitte

but it must be kept within the legal limit above described. The officer occasionally checks priming operations, and casks which have been primed are required to be retained in stock for one hour so as to afford the officer an opportunity to sample for analysis should there be reason to suspect that the limitations in the use of solution have been exceeded. The process of priming gives a briskness to the finished article, which is supposed to add to its refreshing qualities. Although, as stated, no official account is recorded beyond that relating to priming operations of the proceedings conducted in beer cellars and in stores, the officer keeps every room, place, cellar, and vessel under close observation, and the least indication of fraudulent intent upon the Revenue would become the subject of immediate investigation and report to his superior officer.

5333. (*Chairman.*) With regard to priming, when priming is put into the cask is the whole cask stirred after the priming is put in?—It is.

5334. With a special stirrer?—The usual practice is to withdraw a small quantity of beer from the full cask which has come from the racking vessel, then to pour in the priming, stir up with a stick, and bung up, and then to roll the cask away.

5335. Your officer's test is made after it has been thoroughly stirred?—Yes. I have an illustration of that.

5336. (*Mr. Cosmo Bonsor.*) Would you kindly tell me where the notice of priming is given in the brewing book?—There is no printed title to apply especially to the priming, but the brewers write on the line that they are going to use so much priming for so many casks.

5337. Is priming allowed under any of the Acts of Parliament mentioned in the brewing book?—Perhaps not, specifically. It would be treated more under the mixing regulations—the regulations which permit one brewing to be mixed with another.

5338. You are aware of the 27th Clause of the 1880 Inland Revenue Act?—Yes.

5339. "If any brewer shall conceal any worts or beer so as to prevent any officer from taking an account of them, or shall mix any sugar with any worts or beer so as to increase the quantity or gravity thereof after an account of such worts or beer has been taken by an officer." I take it that in priming the quantity or gravity of the worts or beer has been taken by the officer; the beer is complete as far as revenue purpose is concerned?—Yes.

5340. And the priming is what is called "sugar" under the definition of the Act?—Yes.

5341. Consequently, "If any brewer . . . shall mix any sugar with any worts or beer so as to increase the quantity or gravity thereof after an account of such worts or beer has been taken by an officer and the duty has been charged thereon, he shall for every such offence incur a fine of £100, and the worts or beer in respect of which the offence is committed, together with the vessels containing the same, shall be forfeited." Has that clause been repealed?—I do not remember that it has.

5342. As a matter of fact, I believe that brewers are allowed to prime under what is called an excise regulation?—Yes.

5343. They are allowed to prime up to a quantity?—Half a gallon to the barrel.

5344. At a gravity of 1,150?—Not exceeding 1,150.

5345. But as far as you know, there is no statutory permission?—I am not aware that there is a Statute specifically referring to priming.

5346. The Commissioners of Inland Revenue or of the Treasury have allowed brewers to prime under special regulations of their own for which no doubt they have powers?—They are allowed to prime on the instructions from the Commissioners.

5347. In the brewing book that is provided to a brewer there is practically no printed form of notice of priming?—No, there is not. He writes on the line, as I explained just now.

5348. You have been good enough to give us the practice that has been general since 1880 in breweries by the Inland Revenue officers. Has any change been made since this unfortunate epidemic occurred in Manchester and Salford, any change in the regulations or any further instructions given?—No change in the regulations has been made.

5349. I presume it was reported by the Inland Revenue officers to Somerset House?—Yes; considerable anxiety was expressed by the Commissioners to know what was being done. I was called upon to report as fully as I possibly could the whole of the facts of the case.

5350. You are aware of a clause, I suppose, in the 1888 Act which gives powers to the Inland Revenue to stop any deleterious or noxious substance going into a brewery?—Yes.

5351. Have any instructions been given you under that clause?—Instructions would be issued immediately after the passing of the Act; that is the usual practice. When an Act of Parliament is passed we receive instructions from the Board as to the way in which the provisions of the Act should be enforced, and though I do not remember for the moment, I have not the least doubt that similar instructions were issued when that Act became law.

No action taken by I. R. under 1888 Act in view of epidemic.

5352. When it came to the knowledge of the Inland Revenue that a noxious substance in the state of arsenic was going into the beer, did you take any action under the powers of that Act?—We were like everybody else; we were very much astonished to hear that arsenic had been found in the beer. It did not occur to me as collector here to ask that any steps should be taken.

5353. I can quite understand it. I am not censuring in any way?—The clause to which you refer as to any substance or liquor which is capable of being used in the manufacture and so on which may affect prejudicially the interests of the Revenue——

5354. There is more: "Any substance or liquor of a noxious or detrimental nature, or——" I am perfectly aware why this clause was passed; it was for the purpose of stopping the saccharin used in brewing: practically for the protection of the Revenue?—I have a note to that effect. I intended to mention it if my attention had not been drawn to the matter. The assumption is that the Department would know of these noxious materials. If we knew that a brewer along with his malt and sugar was going to add something that was considered objectionable——

5355. Such as arsenic?—No man in his senses would do that. If we saw he was about to add something we considered would be deleterious, of course it would then become out duty to take cognisance of the fact and report the matter for instructions.

Excise officers have power to take samples of brewing materials.

5356. I think you have powers to take samples of any material used in brewing for the purposes of analysis?—Yes.

5357. At any time or any hour?—Yes.

5358. And practically your officers are continually in supervision of a brewery?—Yes, at the large ones.

5359. Have you any suggestion to make to the Commission as to how that supervision could be better used for the protection of the public? Not for the protection of the Revenue, but for the protection of the public from a similar outbreak?—We exist solely for the security of the Revenue, and I am not aware that we could do anything more than that. We find it to be sufficiently arduous and exacting to secure the Revenue. I am not prepared to make any suggestion as to throwing upon the Department the responsibility for the purity of the article; those impurities having got in accidentally.

Excise officers' duties to secure revenue.

Principle of granting rebate of duty on contaminated beer.

5360. I should like to ask one or two questions as regards what happened when the beer was incriminated from having arsenic in it. The brewers, I understand, asked to get a drawback on the beer that had been brewed. Had you powers without going to London to give that drawback?—No.

5361. You had to get a special permit from the Board of Inland Revenue in London?—Yes.

5362. I believe in nearly every instance you gave a drawback to beer that had not left the premises of the brewer?—There have been some, perhaps, nine or ten, cases settled—others no doubt are pending—wherein the brewer has been repaid the duty on the beer that had not left his premises.

5363. Was there any delay in finding the quantity of beer upon which the drawback was claimed?—No delay. That rested with the local officials. I made special arrangements with the various supervisors and officers to take the accounts immediately. I remember in one case a very zealous supervisor with one or two officers were at work until 10 or 11 on Saturday night, and spent six or seven hours there on Sunday to expedite the account.

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5364. To get the quantity and sample for the purpose of providing the specific gravity for repaying the duty paid?—It was not then decided whether the duty would be repaid; that depended entirely upon the action of the Commissioners, but it was our duty locally to secure the accounts so that, if upon consideration the Commissioners thought proper to repay the duty, it could be done. The great concern of the trade was to get empty casks into which to put their new beer. It was for that reason, more than to get the duty back, that I made these special arrangements in order that their business might not be interfered with unduly.

5365. Has all the beer been destroyed now or do your officers know of any still undestroyed?—We have had no knowledge whatever of the beer in the cellars of the publicans, but the whole of the beer that was supposed to be contaminated and which the brewers presented to us to take account was taken an account of immediately, within two or three weeks perhaps.

5366. And has it been destroyed under the supervision of the officers?—Yes; the whole of it was destroyed under the supervision of the officers immediately after each account was taken.

5367. What happened about the beer which was in the publicans' cellars?—We have no cognisance of that.

Contaminated beer which had left brewery not considered admissible for rebate.

5368. Not if it was brought back to the brewery?—No. Beer once having left the brewery is inadmissible for repayment of duty, whatever may be wrong with it. Beer that has gone sour, for instance, or that has spoiled from any other cause, if it has once left the brewery, is not admissible for repayment of the duty.

5369. Under what Act of Parliament?—I cannot tell you at the moment, but it is so.

5370. Under an Excise regulation possibly, but not under an Act of Parliament?—The point has been considered by the Commissioners, and the decision has been arrived at that the beer which had left the brewery premises is not admissible for repayment.

Rebate granted on exported beer.

5371. Beer which leaves the brewery premises to go abroad to be shipped to a foreign port is admissible for drawback?—Certainly.

5372. And whether it goes from a brewery or from the public-houses or from an agent of the brewery, it is still admissible for drawback?—If the beer can be traced, that is, the brewing can be traced, and we satisfy ourselves as to the original gravity and so forth, we can.

5373. I do not think there is anything about satisfying yourself if beer is exported from the United Kingdom. It can claim a drawback on the specific gravity?—True. Samples are taken at the port of exportation, and these are submitted to the analyst, and the original gravity is determined. But the brewer declares.

5374. The brewer as a rule is the exporter, but it is not absolutely necessary. There are agents who do export beer and very likely get a declaration from the brewer?—The brewer makes a declaration, and sends it on to the shipping agent.

5375. The incriminated beer that was delivered to a public-house or the agent of a brewer might have been shipped abroad and the brewer could make the declaration; why should not it have a drawback if it was shipped?—In case of doubt of that kind we should submit it to the Commissioners for instructions.

5376. But the Commissioners have ruled that beer is outside the drawback?—That which has been to the publican's cellars and has been returned. I am not aware that a decision has been arrived at on the point as you put it as to beer exported.

5377. It was not exported, but what I was asking you was, supposing that beer, instead of being returned to the brewery, had been sent on board a ship it would have been liable for drawback, but because it was returned to the brewery to be destroyed it was not liable to drawback?—It is liable for drawback simply because it leaves the United Kingdom.

5378. (*Chairman.*) But if it left the United Kingdom in a ship, and was poured into the sea three miles out, would it get the drawback?—I cannot say what we should do under such circumstances.

5379. I think it is clear that if an owner of a tied house or a publican had intimated that he was going to ship away from the United Kingdom he would have got the drawback?—If he had stated that he wanted to ship it three miles out to sea, and then turn it into the sea, I think we should have hesitated as to repaying the duty.

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5380. That is to say, unless he shipped it to some foreign place, to poison people there, he would not get the drawback?—As to the question of poison, of course we did not know it was there for a considerable time.

5381. But when this question was raised it was already known to be poisonous beer?—Yes.

5382. This does not commit anybody, but I understand that according to the action of the regulations that were insisted upon at the time by the Commissioners, the publican might have shipped and sold to foreign parts, and would have got the drawback?—I am not so sure about that. If our suspicions had been raised, I think the Commissioners would have hesitated before paying the drawback. If there is anything to suggest a suspicion that the exportation is not bonâ fide for a foreign country, any officer with a head on his shoulders would at once take steps to stop the fraud, as I should consider it.

5383. (*Mr. Cosmo Bonsor.*) Fraud on whom?—On the revenue.

5384. Why on the revenue? It has received the tax?—For obtaining the drawback improperly.

5385. But the brewer has paid the tax. It cannot be any fraud if he is not going to sell it afterwards?—His Lordship is speaking of a hypothetical case, I suppose, where beer is sent away and proves to be poisoned beer.

5386. (*Chairman.*) It does seem that as drawback is admissible in certain defined cases, in this unprecedented case which might be classed technically with those in which drawback was allowed before, the drawback could here also be allowed on reconsideration. Perhaps on appeal to the Commissioners the would allow the drawback?—Any case of doubt would be submitted to them. We should not entertain a case of drawback unless it was perfectly clear and straightforward. The least doubt on any point we should, according to our instructions, submit for the Commissioners to decide upon.

5387. (*Mr. Cosmo Bonsor.*) It has been decided by the Commissioners that no drawback is to be allowed on beer in a licensed victualler's cellar?—I think I saw it in a newspaper report, but I do not know officially that the point has been brought to the attention of the Commissioners by those interested in brewing, and that they have decided not to allow repayment.

5388. You have no instructions upon it?—No.

5389. (*Chairman.*) Has any request come to you and been passed on by you to the Commissioners for drawback in respect of the recent epidemic?—A considerable number of applications went up to the Commissioners, some of which have been decided, as I have said, but, so far as I am aware, in every case the application related to beer which had not left the premises.

5390. And you do not know of cases in which the beer had left the premises and drawback asked for it?—I do not know.

Excise officers to account of wort.

5391. (*Mr. Cosmo Bonsor.*) With regard to the question of brewing, is it part of the duty of the Excise officers to see that all beer, when it is collected in a vessel, goes through the process of fermentation?—No.

5392. As long as they collect the revenue, they are satisfied?—That is so. We are not there to see that the wort is fermented, that is, that every portion has yeast added to it. They simply bring their wort to charge, whether in the form of solution or in any other form, and we take the account when it is collected in the proper vessel.

Brewer n add unfer mented s and decla it as a wo

5393. So that it is possible that sugar might be added to fermented beer having paid the revenue as beer brewed?—That is so; that is a common practice.

5394. Is it a common practice in this particular district?—Do you mean the use of solution?

5395. What I call a sugar solution which has not fermented?—I think it is common all over the North of England, so far as my experience goes.

5396. That is, that an unfermented wort is added to a fermented wort to complete the gyle of beer?—That is so.

5397. It is done under two declarations?—As you are

aware, the sugar solution is not capable of fermentation.

5398. Unless yeast is added. Is it allowed as a "brewing"?—Technically it is called a brewing.

5399. Under the Act?—Presumably so.

5400. I should like to know what clause. Why I am asking you these questions is that the Excise authorities seem to me to have been so very strict as regards giving a drawback on beer which was poisoned, and allowing that beer to hang about, it may be, to the prejudice of the public, and yet when it is a question of revenue they seem to go outside their Act of Parliament?—I think you cannot fairly hold the Commissioners responsible for holding the beer about which was poisoned. As I have tried to explain to you, I personally adopted the most prompt measures to take an account in the breweries in order that the beer might be destroyed at once.

5401. But surely the beer in the publican's cellar was infinitely more dangerous than in the breweries?—That did not come within our cognisance; we have nothing to do with it when it leaves the brewery; we should have required a staff 200 or 300 per cent. greater.

5402. You do work in the publicans' cellar?—For certain purposes.

5403. To find if it is diluted with sugar and water, in order to prosecute?—Yes.

5404. If it was a question of the public health, and not a question of the revenue, you do not act?—It is not defined that we are custodians of the public health. We are employed for financial purposes.

5405. And to prevent deleterious and noxious substances entering?—When these ingredients are presented to us in brewing.

5406. (*Dr. Whitelegge.*) Are your instructions written or printed?—Printed. I receive a good many written instructions, but those that are issued for the guidance of the department generally are printed in the form of what we technically call General Orders. But in specific cases, written instructions are sent for guidance.

5407. Do any of those instructions, either general or specific, turn upon the question of damage to the public health in the ingredients used for brewing, or are they solely concerned, so far as the section of the 1888 Act is concerned, with Excise questions?—So far as I can recall, they are confined entirely to the Excise aspect of the question.

5408. There is no instruction suggesting that you should send samples in the event of any supposed danger to health in any ingredient found in the brewery?—In the matter of samples we are left almost entirely to our own discretion. If we knew that there was something wrong in the beer, we would send up a sample.

5409. Has that been done in any instance in your knowledge on the score of danger to the public health?—No; I do not know that it has. We have had no reason to suppose that there has been any mischief of that kind. The brewers are usually careful in their selection of materials to get a wholesome article, so that the matter has never been brought to our notice specifically.

5410. Does it practically come within your survey as a matter of instruction to see if the Bostock sugar is in use in a brewery?—No.

5411. If you found a sample of sugar in a brewery which you believed to be Bostock's, at the present day, what steps would you take?—If I as an officer were to find a sample, I should at once send it up to the Commissioners, and allow them to decide what should be done in the matter.

5412. Is that under instructions?—No.

5413. As a matter of common-sense?—Precisely. We are not tied down, although we are credited with being so, with red tape. We are expected to use our judgment and our common-sense in any difficulty which may arise.

5414. You know it has been suggested that malt often contains arsenic?—Yes.

5415. Do you at the present time take any action in that respect?—None whatever. You mean as to ascertaining the purity of the malt—freedom from taint.

5416. Yes, and ascertaining whether the brewer has taken any precautions to guard himself against arsenicated malt?—No. That does not come within the range of our instructions.

5417. Do you send samples from time to time of all the various brewing ingredients?—Yes. *Mr. H. Spencer.*

5418. (*Chairman.*) Do you analyse yourself here or by your own officers?—No; we send to London to the Government laboratory. 30 Mar. 1901.

5419. Under Dr. Thorpe?—Yes.

5420. (*Dr. Whitelegge.*) I have a long list here from the evidence given before the Departmental Committee on Beer Materials—a long list extending to two pages—of various substances used. May I take it that you are empowered and instructed to take samples from time to time, as you find occasion to do so, of all these materials?—Are they brewing materials?

Selection of samples sent to Government laboratory governed by revenue considerations.

5421. Materials that go into beer. Do you send samples only of malt and malt substitutes?—We send samples of everything that is used in the brewing which is supposed to give saccharine value to the wort.

5422. That answers my question. You would not be concerned with such things as preservatives or colouring ingredients?—The colouring matter—that is the caramel—we have taken account of on account of its sugar value.

5423. You send samples from time to time of caramel?—If we have occasion to do so. The practice is for the brewer to enter the weight of the caramel in the brewing book, and we accept that and find its sugar value at the end of the month.

5424. But the instructions do not carry you further than this, that from time to time samples are to be taken and forwarded to Somerset House of any material that is likely to affect the Revenue?—The whole object of sampling by the Revenue officers is to ensure that we get the full brewing value out of the materials, and that nothing is used which adds saccharine to the wort, the value of which cannot be ascertained by the saccharometer. The special substance, saccharin, for instance, has already been referred to. That is one of the ingredients that is prohibited, the only one, I think, which has been prohibited since 1888, when the Act was passed.

Prohibition of saccharin.

5425. Do you know on what ground saccharin was prohibited?—Because we cannot ascertain its brewing value.

5426. Not because it is supposed to be prejudicial to health?—Not on that account.

5427. (*Chairman.*) Does the saccharometer measure saccharin?—No.

5428. Saccharin is a chemical discovery of some 10 or 15 years?—Yes.

5429. But the saccharometer takes no cognisance of that?—It does not.

5430. Does the saccharometer ordinarily indicate by gravity?—That is so.

5431. Not by the optical property?—By gravity solely.

5432. Is the optical property used at all in your tests?—We do not as officers. Our only means of ascertaining the gravity is by the use of the authorised saccharometer.

5433. (*Dr. Whitelegge.*) May I take it that the central authorities know of all the ingredients of beer?—Do you refer to the ingredients mentioned in this book, maize grits, rice, and the other things?

5434. (*Mr. Cosmo Bonsor.*) Everything except the antiseptics?—None whatever of the preservatives.

5435. (*Dr. Whitelegge.*) They have no record of that?—None whatever.

Extent of information as regards brewing materials required by I. R.

5436. They have no record of the detail of the ingredients going into beer?—Further than is necessary for revenue purposes.

5437. Grouped, that is, under broad headings?—Broad headings, as detailed here.

5438. Would it be possible for the Inland Revenue to obtain information of every ingredient going into every brewing of beer?—I am not in a position to say.

5439. (*Sir William Church.*) Could you tell me how the brewers got information that the Commissioners would not allow any drawback upon beer that had left the breweries? We have had several pieces of evidence before us, and when we asked why they had not made an application for a drawback, they said they were told it was no use?—For some years there have been occasional instances where repayment of the duty has been claimed on beer in consequence of its having become

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sour or unfit for drinking from any cause, and when such beer has not left the brewery premises the repayment is allowed; but the brewer has to make a declaration that it has not left the brewery premises, and the brewers being accustomed to this for a number of years, I presume would naturally infer, having the practice of spoilt beer before them, that the beer in the publicans' cellars would not be entertained for any repayment. It did not occur to me at the moment when Mr. Bonsor was asking me questions, but I may say that immediately it was found by the brewers locally that there was something wrong with their beer, several of them came to see me to ask for assistance in the matter, and in the course of conversation I told two or three of them, and no doubt the matter would get noised abroad, that I was of opinion that the Commissioners would not entertain an application for repayment of duty on the beer which was in the publicans' cellars. In one case I remember a certain number of casks were mentioned, but perhaps I had better not repeat the figures; and I remarked: "You had better let that go down the drain at once, as the Commissioners will not pay you." I believe the firm acted on the suggestion, and destroyed the beer at once, in order that they might get the casks back to be filled with wholesome beer.

Rebate refused on beer which had left brewery.

5440. So far as you are aware, there has been no formal application made to the Commissioners by any brewer?—I think I have good reason for saying that representatives of the brewers approached the Commissioners in London directly, and did not go through me. I simply heard that; I have no official knowledge.

Decrease in consumption of beer in Manchester in 1900.

5441. (*Mr. Cosmo Bonsor.*) Could you tell us if there was any great falling off in the consumption of beer between July and November when it became apparent?—I thought perhaps something might arise on that point, and for my own satisfaction primarily I caused an abstract to be made, which I will read to you. This refers to Manchester collection.

5442. Does that include Salford?—Yes. I commence with October, 1899. The mischief commenced in November, 1900. October, 1899, 4,696,932 gallons; October, 1900, 4,368,473 gallons—a decrease of 328,000. I think we know why that decrease arose. November, 1899, 4,934,747; November, 1900, when the mischief came to light, 3,955,200—a decrease of 979,000. December, when brewers were busy restocking their cellars, 1899, 4,482,473; December, 1900, 4,463,000 odd—a decrease of only 19,000. In January and February it becomes natural again, nearly 4,000,000.

5443. (*Chairman.*) The decrease in October and November, do you attribute that to the illness caused?—I have no specific reason, only the suggestion of the figures. I have made no inquiry.

5444. (*Dr. Whitelegge.*) The figures relate to the beer brewed?—Yes, the bulk gallons.

5445. Does it take any account, or is it affected by the amount destroyed?—I think so, in December. I suggested, when reading the figures, that the comparison was good presumably because the brewers were restocking the cellars to make up for the destroyed beer.

5446. (*Mr. Cosmo Bonsor.*) We had evidence from one brewer there was a good deal of dissatisfaction with the beers as early as August, and that people had given up drinking beer, I think the expression was. Was there any falling off in August or September that the Excise would notice?—I did not go so far back. For my purpose I thought October would be early enough.

5447. (*Chairman.*) You were going to give us the outline of the nature of an officer's duty at a brewery?—Shall I go on with that? I have described the breweries as X and Y, and it would be more satisfactory if you would take the evidence confidentially.

ELEVENTH DAY

AT WESTMINSTER PALACE HOTEL.

Friday, 26th April, 1901.

PRESENT:

The Right Hon. LORD KELVIN (*Chairman*).

The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Professor THORPE.
Mr. COSMO BONSOR.
Dr. WHITELEGGE.

Dr. BUCHANAN, *Secretary.*

MR. HENRY A. TAYLOR, called; and Examined.

Mr. H. A. Taylor.

5448. (*Chairman.*) You are maltsters of Ware?—Yes, and Sawbridgeworth, which is our business address.

5449. You are a practical maltster, and acquainted with the system of malting practised in a considerable part of England?—I have been a maltster 25 years.

5450. And where in particular have you most experience?—At Sawbridgeworth and Bishop's Stortford in Hertfordshire.

Process of malting on kiln floor described.

5451. The process adopted nearly everywhere in your experience is malting on the floor, is not it?—Yes. In a few isolated cases pneumatic malting is adopted.

5452. Will you briefly describe the process of malting on the floor, and we shall afterwards hear about the pneumatic malting?—In the floor process the barley, after being received from the farmer, is sweated or slightly dried on the kilns. After that it is put into the barley lofts and then shot into screens to remove all imperfections in the way of light corn, etc. It is then put into the cisterns for a certain number of hours; after that it is moved on to working floors for germination, and when sufficiently converted is loaded on the kilns.

5453. In the first drying is it exposed to the fumes of the fire?—Yes.

5454. Coming through fine holes in the floor?—Through an air shaft generally.

5455. (*Mr. Cosmo Bonsor.*) On wire?—Wires too.

5456. (*Chairman.*) An air shaft coming under the wires?—Yes.

5457. And the grain is placed on wires?—Yes, on wires or tiles; in some cases perforated tiles.

5458. Perforated earthenware tiles?—Yes.

5459. In other cases on wires?—Yes, iron wires.

5460. Is that wire cloth?—Yes, wire netting, or in some places wedged-shape bars.

5461. When the floor is perforated tiles, are they very fine perforations?—Yes, very fine perforations.

5462. With regard to the screening, that is done after the first drying?—The screening of malt previous to delivery do you mean?

Screening barley.

5463. The screening you have already spoken of?—That is the screening of barley.

5464. Before it is malted?—Before it is put in the cisterns.

5465. Then you have one process of screening before the malting commences?—Yes.

5466. After that?—It is then put into cisterns to steep, and then after a certain number of hours it is thrown out on the working floors to germinate, and when sufficiently converted, it is laid on the kilns, where it is kept for two, or three, or four days according to the capacity of the kilns and mode of working.

5467-9. It is first of all soaked in the cistern for some hours, and becomes I suppose slightly swelled?—Yes.

5470. How long is it undergoing the germinating process?—It depends on the weather, from eight to fourteen days.

5471. During that time the rootlets show themselves outside?—Yes.

5472. After the germination, what is the next step?—It is loaded on to the kilns.

5473. How much heat does it get on the kiln?—It is a gradual process. We start at 90°, and it depends on the character of the malt, what it is meant for, how high we dry it. With pale malt we go up to 180° or 220°, and very high dried malt to 220°, or 250°.

5474. The rootlets are on the grain during all this time?—Yes.

5475. Do they break off?—They do a little in turning. It is turned several times on the kilns.

5476. Is a good deal of dust left on the kiln after that turning?—Yes; some percolates through the wire flooring a little.

5477. Have you ever examined the dust on the floor due to the turning irrespective of screening and before screening?—Do you mean chemically?

5478. The dust is swept away from time to time?—No. some of it percolates through, and when there is sufficient there to remove in any quantity it is taken out.

5479. From where?—From under the wire.

5480. Swept out?—Yes, taken out altogether, cleaned.

5481. I suppose that consists chiefly of radicles?—And the chafings off the malt.

5482. Have you ever examined that dust?—No.

5483. That dust will be liable to have any incrustation that may come from the fumes?—Yes; a certain amount is collected, no doubt.

5484. So that if there was arsenic in the fumes, it would be found in that dust?—I should say a certain proportion, yes.

5485. That has not hitherto been examined chemically?—No; I do not think so.

5486. What is done with the dust?—It is sold for manure solely, as far as my experience goes.

5487. Sent away dry in bags?—Yes, and put on the land.

5488. We have got as far as removal from the drying floor. The kiln process you have described would not be called roasting, would it?—No.

5489. That never blackens the malt?—No.

5490. So that whether it is for pale beers, or ale, or for stout, dark or black beers, the process so far is the same?—Yes.

5491. Is the palest beer made from malt not so highly dried?—Yes.

5492. And less pale beer from more highly dried?—Yes.

5493. But none of this drying is sufficient to make black stout?—No; black malt is made in cylinders.

5494. What is the next process after removal from the floor?—A second screening, and sometimes a third one.

5495. How is that screening conducted?—In several ways. One way is simply through a plain screen where the rootlets drop through, and another way is to brush it and to take the thin corn out, and that kind of thing.

5496. What kind of brushes are used?—Revolving brushes.

5497. Of what kind of material—wire?—Wire, yes.

5498. Always wire?—No; bristles, as well as wire. Brushing is very little resorted to.

5499. The screening is generally sufficient?—Generally considered sufficient.

5500. What is the screening—shaking it?—In some cases. In other cases it is simply thrown in a hopper and allowed to run down a flat screen.

5501. What is the screen exactly?—It is a wire screen, made something like the wire floor, only not so stout.

5502. And then falling down on the floor shakes the dust sufficiently off?—After falling down the screen the dust goes through the wire, and the malt comes out at the foot of the screen.

5503. If it merely falls on the screen, is there anything to take the incrustation off the malt that may be on it?—I do not quite follow you.

5504. Is the falling down in the screen sufficient to shake off any incrustation there may be?—No, it merely takes away the radicles and fine dust.

5505. Sometimes I understand it is shaken backwards and forwards?—Yes, that is another mode.

5506. What is the object of that?—It does its work rather better perhaps.

5507. Makes the one grain rub on the other?—It gets the malt rather cleaner.

5508. What is the chief thing removed in that process?—The rootlets.

5509. Is there much done also in removing incrustation?—No, I think not in the ordinary screening. If you brush malt it does undoubtedly.

Brushing malt.

5510. The brushing is not always conducted?—Very seldom resorted to.

5511. In what circumstances do you resort to brushing?—It was originally resorted to to remove the mould and other outside imperfections in malting. Of late years brewers have objected to it for a very good reason that it gives an artificial value to malt.

5512. How is that?—It makes a better appearance; it cleans it up and makes it look a better article than it is. A good many brewers object to it and rightly.

5513. Why rightly?—Because I do not think it gives the maltster who is careful a chance.

5514. Why not?—Because the man who has made mouldy malt can brush his malt and make it look as good as the man who makes it without.

5515. If it is good malt and not mouldy is there no incrustation to take off generally?—No, very little. If you brush malt you will always get something off it, however well made it is.

5516. Is there not generally some sulphur or other incrustation from the fumes which should be removed?—I think not. If malt is carefully made I do not see there can be anything.

Duration of kilning.

5517. How long is the malt usually on the kilns?—From two to three or four days, it depends on the modes of drying, some people dry with fans which takes less time than the other. Other people dry simply with the gradual process, and there are various other methods. One man does it one way and one another.

5518. How long a time elapses before the germination is stopped by the kiln?—At once, it should be.

5519. The first exposure?—Yes; afterwards it is a gradual process.

5520. What fuel or fuels are used for the kilns in the maltings of which you have had practical experience?—Our own maltings only, do you mean?

5521. Or in those of which you have had experience?—In our district anthracite coal is nearly always used. Occasionally coke is used, but it does not pay in our district; we cannot use it.

Cost of malting fuel.

5522. Is the cost of the coal in the malting process much in comparison with the whole expense?—Yes, it comes to about nowadays 1s. to 1s. 6d. a quarter.

5523. And the whole process, labour, appliances, capital on plant, etc., the total expense of the malting is what?—About 6s. to 7s. per qr. The fuel is about one-fifth.

5524. One-fifth of what?—Of the total expense of making the malt.

5525. (*Sir William Hart-Dyke.*) The fuel?—Yes.

5526. (*Chairman.*) In your total expense you reckon interest on money, building, malting floors, etc., do you?—I could hardly answer that off-hand.

5527. There is not a great expense because the wages are not large?—The wages are very large indeed.

5528. Three or four times as much as the fuel?—No, certainly not that.

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5529. Have you had any chemical analysis of the fuel?—From what we can gather from analysis the best anthracite coal contains little or no arsenic, and we are told that coke does; but personally we have no practical experience, as we use only coal.

5530. Only anthracite coal?—Yes.

Anthracite containing negligible amount of arsenic.

5531. Have you had analyses made yourselves of the anthracite?—Yes, of the coal we use. I have one here. Here is one made from coal taken from 20 heaps. The analyst reports this: "A sample of coal received from you on April 17th has been tested for arsenic; a minute trace has been found in it which is quite negligible. You can use the coal with confidence."

5532. Are there any tests for sulphur also?—No, not that I know of. We have not tried it.

5533. Previous to last year and the scare, had you ever any test of the anthracite?—None. We have made no difference whatever in the manufacture of our malt since the Manchester scare.

5534. But you have had analyses made?—Yes, we keep taking them every day.

5535. But you never had analyses made before?—Never as to coal.

5536. Do you find the fuel varies? Do the different supplies vary from one another?—I do not think it does very much, but I do not think you can guarantee—or we are told that you cannot guarantee—coal free from arsenic, absolutely free. You can guarantee it practically free, but not absolutely free.

5537. Does your analyst state quantities of arsenic?—Yes. In this particular report I think it was 1-300th of a grain to the lb.

5538. In one specimen?—That was taken from the bulk; a piece of coal taken from 20 heaps, all smashed up together, and sent to the analyst to report on.

5539. Is that the largest quantity of arsenic that was found?—I should say not. I do not know. That is our experience.

5540. In the other reports you read "a slight trace of arsenic"?—That refers to the same coal.

5541. It was said it might be neglected. This amount you now state is how many grains?—1-300th part of a grain to the lb.

5542. Did the analyst consider that as negligable?—Yes.

5543. You do not know of any larger quantity than that having been found?—I do not know of any percentage; that is the largest we have found in our own.

5544. (*Mr. Cosmo Bonsor.*) That is anthracite?—Yes.

5545. Have you a table of analyses that can appear with your evidence?—No.

5546. (*Chairman.*) You have no further result of analysis?—Not as regards coal.

5547. It would be quite practicable to obtain specimens of the dust from the different stages?—Yes.

Malt dust.

5548. In the screening the dust is carried away in a current of air, is it not?—Yes.

5549. Is it left on the floor?—It is left in the garner or malt loft.

5550. In any of your processes is the dust carried off with a stream of air?—No, only in the brewery.

5551. Since the scare have you had any analysis of the dust?—No, we have not.

Malt tested for arsenic by malteter.

5552. Or of the finished malt?—Yes, any amount. I will read you one of our own malt:—We had samples drawn the other day from all parts of our different bulks of malt, and sent them up to the analyst to report on them. He reported: "All these samples have been tested for arsenic by a severe form of the Marsh test. I have found no arsenic in any of them." But still for all that I do not see that we can guarantee the malt free from arsenic simply because we cannot guarantee the coal.

5553. (*Sir William Hart-Dyke.*) Is that from your own analyst?—Yes

5554. (*Chairman.*) Have you an analyst in your factory?—Yes. We have a laboratory. But this is not from him.

5555. Is he a London analyst?—Yes, this is a London analyst.

5556. Do you put in this statement with your evidence?—Yes. I have not his authority to give his name, but I would put it in.

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5557. There can be no objection to the name being given, I suppose, if you have it? We have always had the names of analysts given. He did not mark his letters "Private and Confidential," did he?—Not that I know of.

5558. Then will you give the name?—Dr. Moritz.

5559. He did not find any trace of arsenic?—No trace of arsenic, and yet I say I do not think it is possible to guarantee malt absolutely free from arsenic.

5560. Have you had any other analysis of your malt?—We have them every day.

5561. By your own analyst?—Yes, and by these people, Moritz and Morris.

5562. Has a trace of arsenic been found?—We have not found any.

5565. Not in any of the analyses?—Not one.

5564. If there was arsenic at all from the fuel it would be in much larger proportion in the dust than in the grain taken away with the dust removed?—We are told so.

5565. It would be first in the dust?—We are told that it accumulates first in the dust under the kiln.

5566. It would be very advisable to have that dust looked to?—It is always removed; it never goes with the malt.

but malt dust not tested.

5567. It would show whether or not a coating of arsenic has been removed?—Yes.

5568. Of course it is very satisfactory that your malt has shown itself free from arsenic, and it would be important, I think, to test the dust, so as to see whether arsenic has been removed?—I think there is no doubt about it that a certain portion has.

5569. (*Sir William Church.*) I think I understood you to say that it did not pay to use coke in your maltings?—It does not in our district.

Coke not used in district.

5570. Why? Is it more expensive?—Hardly more expensive, but we have a great deal of trouble to get it. We have no washed coke in our district at all, and we have to get it from the North.

5571. When you use coke you use oven coke?—Yes, but we never use it simply because of that reason. I am not setting up myself as a model of righteousness about using coke.

5572. We have had it in evidence that oven coke does not contain generally so much arsenic as gas coke, but when you use coke you use oven coke, not for that reason, but because you get it cheaper?—I should use oven coke if I could get it at all, because it would answer my purpose to do it.

5573. "Answer your purpose" means it is less expensive?—No, not always. I should say certainly it would not be less expensive for me to use oven coke, but more expensive.

5574. Why should you use it?—I might be requested to do so; I have been requested to do so by brewers.

5575. (*Chairman.*) Requested to use coke?—Yes, not latterly.

5576. When you have been requested you have done so?—Certainly. Some brewers used to have an idea that coke gave a better flavour to malt.

Some brewers prefer coke dried malt.

5577. Did you ever use peat for malting?—No.

5578. (*Sir William Church.*) It really comes to this, that the brewer objects to the maltster brushing, because an inferior sample of malt is made to appear like a good one?—Quite so. I should suggest that the brewer brushes the malt himself if he wants to.

5579. (*Chairman.*) Why should the brewer brush his malt?—Because arsenic is supposed to be on the outside of the grain, and if there is any left he removes it.

Brushing should be done by brewer not by maltster.

5580. But your malt had none to remove?—So they say.

5581. And since the scare have brewers taken to brushing the malt?—Not that I know of.

5582. It is not their object to make the malt look better, but the object of the maltster might be so?—Yes. It is no use nowadays.

5583. (*Sir William Hart-Dyke.*) With regard to the screening, and the dust that proceeds therefrom after the screening process, I should like you to tell us a little more what happens to this dust?—It is sold for

feeding purposes. The rootlets taken from the malt is sold for feeding purposes.

5584. And the combings?—I mean combings.

5585. They combine the two?—Yes.

5586. The same expression defines both?—Yes.

5587. That is to say, whatever comes from the malt after this process of screening is over?—Yes. It is used for feeding.

5588. This is very largely used, is it not, in some parts of England for feeding purposes?—Yes, we sell it for nothing else. Everywhere it is the same, I believe.

5589. It is mixed for feeding purposes generally with chopped hay or chaff?—Yes, anything.

5590. It is pressed, is it not, in the form of cake usually?—I do not think so. There are malt cakes, but I do not think they are made with dust.

5591. (*Chairman.*) What you are speaking of now would chiefly consist of the radicles brushed off?—Yes.

5592. (*Sir William Hart-Dyke.*) I suppose you have not had time to read some of the evidence given already before this Commission as to the quantity of arsenic that has been found in malt dust?—I know there is a certain proportion. I can quite understand it.

5593. Have you read that in one or two instances a very large quantity has been found?—Yes. That is principally in the kiln dust, that is to say, the dust that percolates through the wire floor. I have not heard that it is contained in the malt dust itself after the process of kilning. I daresay it is.

5594. There are two kinds of dust, so to speak, that is, the kiln dust and the dust which after this process of screening is used for feeding purposes for stock?—Yes.

5595. Is this kiln dust, to your knowledge, ever used for feeding purposes?—Never; cattle will not eat it.

5596. You know of no instances in which this kiln dust has been collected and attempted to be used for feeding purposes?—No.

5597. It has not come within your knowledge?—No.

5598. It is not a practice?—No. It is sold at a much lower price, and used for manure on land solely.

5599. Personally have you had any analysis made of these combings?—No.

5600. Or dust used for feeding purposes?—No.

5601. Can you tell the Commission of any instance in which it has been analysed lately to discover whether it contains arsenic?—No, I cannot personally.

5602. All you know is what you have really read of the evidence given before this Commission with regard to the dust which has been found in the kilns?—Yes.

5603. I should like to put a general question to you with regard to your business as it is to-day. From all you know now concerning this arsenic which has been found in malt, have you any fear in carrying on your business in the future, with moderate care, including the application of analysis, as regards the immunity from poisoning in beer?—I do not see any fear myself. If good anthracite coal is used in the manufacture of malt I think there need be no fear of producing a malt practically free from arsenic. But I think some standard should be given to work to. It should be stated in some form or other what malt may contain, and how much, and let us work to that.

5604. What you mean is that it is impossible to guarantee absolute freedom from arsenic, but if you had a standard fixed, and could always produce your malt at that standard, and never exceed it, you would have absolute security?—I think so, certainly. At present it is upsetting the trade for nothing.

5605. Although you have been at the expense and trouble of analysing this coal you use from time to time, you have not personally any experience as regards the analysis of coke, oven, or gas coke?—No, we have no personal experience.

5606. All you know in regard to coke is by hearsay, or what you have read?—What our analysts tell us.

5607. (*Mr. Cosmo Bonsor.*) You alluded to mouldy malt: can you tell the Commission how the mould arises on the floors?—From inferior knowledge and manufacture.

5608. Does it not arise from cracked kernels?—Certainly.

5609. But that is not the maltsters' fault?—No, it is not.

5610. Have you had experience of malting barley which has been threshed by a flail?—Certainly.

5611. That barley would be freer from mould than barley threshed by machine?—Yes. It has been the curse of the trade all through, this threshing machine. At the present time we have broken the neck of it. We have absolutely refused to buy stuff which is broken and knocked about, and so we have made the farmer take more care and trouble about it, and now he produces an article to us which is far and away better than what it used to be.

5612. I think that foreign barley is much freer?—Yes, generally speaking, but not altogether so; it all depends on the sort you buy. There we have had exactly the same experience; until we stuck out that we would not buy barley knocked about by the machine we could not get it altered.

5613. After the barley has been on the floor, and got mouldy, has it been the practice to your knowledge to throw sulphur on the kiln fires for the purpose of removing it?—Certainly. Sulphur added to kiln fire.

5614. It is not a practice of your own?—No, it is not, but it is practised, and to no harm.

5615. It depends on the sulphur, does it not?—They guarantee the sulphur absolutely free from arsenic.

5616. Is there any practical way of telling whether malt has been dried with sulphur added to the fire or not?—There may be, I have never heard of it. I have sent up samples to be analysed in that way, but it has not been discovered.

5617-8. (*Sir William Church.*) When you sent those samples up for analysis did you send them up for analysis of sulphur?—No.

5619. Then they would not be examined for it?—No.

5620. It would be only examined to see if they contained a proper amount of maltose and that sort of thing, and therefore the analysis proved nothing with regard to sulphur?—No.

5621. You do not think if sulphur fumes pass through the malt there would be sulphur deposit on the malt?—I do not think so.

5622. (*Mr. Cosmo Bonsor.*) I was asking whether there was any practical way, independent of chemical analysis, of getting at the fact of whether sulphur had been used in the fire or not?—I think you can see it; I can see it.

5623-4. And taste it?—Yes. It brightens it. I think it is very little practised at the present day. It used to be enormously practised, but it is no good at the present day. The brewer does not buy the malt only by sight.

5625. Was the sulphur used for any other object than to kill the mould?—Yes, to give it a better appearance, to make it more marketable.

5626. But not to make it really better for brewing?—Certainly not.

5627. (*Sir William Church.*) It does have a beneficial effect on the malt; it brightens rather dark grain sufficiently to enable it to be used for lighter-coloured beers, does it not?—No.

5628. (*Mr. Cosmo Bonsor.*) Brewers object to malt being sulphured?—Certainly.

5629. If they knew it, they would not buy it?—Certainly.

5630. (*Dr. Whitelegge.*) Since when has it been the practice to examine sulphur for arsenic?—I do not know that it has been examined.

5631. I thought you told us the sulphur was guaranteed free from arsenic?—So it is.

5632. Can you tell us when that began?—No, we have it guaranteed ourselves from the people who use it.

5633. In the case of the sulphur you use yourselves?—Yes, as an experiment.

5634. Since when have you used anthracite?—We have never used anything else. Anthracite always used at his maltings.

5635. You gave us particulars of some of the analyses of coal; were any of those samples of coal entirely free

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from arsenic?—No; I gave you a report of all our coal taken from different parts of the bulk, and smashed up together, and sent up to the analyst to be reported upon.

5636. Only one analysis was made?—Yes, that is all.

5637. And arsenic was found in very small quantity?—Yes.

Selection of samples of fuel for analysis.

5638. But you cannot say whether any of the samples of anthracite coal you used were entirely free from arsenic?—I should say it was not; it might have been.

5639. It is conceivable that if out of the twenty samples, or whatever it was, if one contained a great deal of arsenic, that fact would not appear in an analysis made of an average?—I picked out all the worst pieces I could find in selecting this coal; I wanted to find it out.

5640. But the analyst only made one analysis, it was an analysis of an average, and not of a separate portion?—No.

5641. (*Sir William Church.*) What do you mean by the worst?—What I thought was the worst.

5642. Those which had traces of iridescence on their surface?—Yes.

5643. (*Chairman.*) Is not pyrites visible in the anthracite?—Yes.

5644. You spoke of the threshing machine being severe on the barley by breaking up the grains?—Yes; inferior threshing smashes the corn, breaks it in half.

5645. Does not that destroy it for germination?—No, altogether. It skins it, and produces mould on the floors.

5646. The old threshing by flail was safer?—Far better.

5647. Is that practised now?—Very little. They would never get through it.

5648. (*Dr. Whitelegge.*) Can you say why it should cause mould?—I do not know that I could.

5649. (*Mr. Cosmo Bonsor.*) There is another form of mould, what we used to call red mould. What does that come from?—Really from injured grain, or rotten grain, badly harvested grain.

5650. Not from the manure used?—I cannot think so. I think it comes from badly harvesting stuff, it is not in proper condition when it is put into the stack.

5651. It has been suggested that the use of guano and different things would produce a red mould on the floor?—I know it has, but I do not follow it at all.

5652. The red mould is rare now since barley has been kiln dried?—It does not have quite the same effect, but still it is there in bad harvests.

Brown malt dried with wood. Black malt roasted in cylinders.

5653. (*Chairman.*) Then, as to the mode of preparing dark malt?—Do you mean brown malt or black?

5654. Black or brown?—Brown malt is dried with wood, black is dried in cylinders.

5655. Brown malt is dried with wood instead of anthracite coal?—Yes.

5656. Is that much used?—It is used for stout and porter.

5657. Would wood not give malt suitable for pale ale?—No. It could not be used for pale malt.

5658. Is the wood much more expensive than the anthracite coal?—Yes, it costs more to make brown malt than it does pale.

5659. The black malt is produced by roasting in cylinders?—Yes; pale malt is made first, and then put into cylinders.

5660. And there is no distinction between the malts afterwards put into cylinders?—Can you put any malt into the cylinders?—You could do so, but the malt that is put into cylinders for black malt does not require the same amount of germination and flooring that making pale malt does. You curtail the flooring.

5661. In the cylinders it is not exposed to fumes from the fire at all?—No.

5662. (*Dr. Whitelegge.*) But it has been exposed to the fumes at an earlier stage?—It has. It is made into pale malt to begin with.

Pneumatic malting described.

5663. Do you know of maltings where a pneumatic system is adopted?—Yes. I have one of my own. The system to start with up to the cistern, is the same. After leaving the cistern the grain is put into drums or squares and cold air, or moist air is drawn through the grain. It is then laid on the kilns exactly in the same way as in ordinary floor malting, and the same process proceeds as in the ordinary floor process.

5664. Laid on a floor through which the fumes pass?—Exactly the same way as the ordinary floor system of malting.

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5665. What is the effect of the pneumatic system?—By it you can malt all the year round, whereas in the ordinary floor process you have to malt when the weather is suitable.

5666. I understand the floor process is used in connection with the pneumatic system?—It is.

5667. But still the pneumatic system allows you to go on with the malting in very hot weather or cold weather?—Yes.

5668. I do not quite understand how the pneumatic system has that effect?—It enables you to malt all the year round if you wish; whereas you cannot do that on the ordinary floor process.

5669. (*Sir William Church.*) The pneumatic system is a different process during the germination of the grain?—Yes.

5670. Not in the drying?—No, in the germination only.

5671. (*Chairman.*) Where does the germination take place?—In the drums or squares.

5672. It does not take place on the open floors?—No.

5673. All the kilning is exactly the same?—Yes. In some cases drums are used for kilning, but it is not thought much of.

5674. Does the drum revolve?—Yes, slowly.

5675. Does that interfere with the germination?—No, if you mean in the germination drum.

Pneumatic malting as employed i England n advantage qua arseni

5676. Does the pressure and temperature differ from that of the atmosphere in the pneumatic system?—We can work at a given temperature, whatever you want to pretty well.

5677. (*Dr. Whitelegge.*) Would the use of this system in any way lessen the risk of arsenical poisoning?—Not at all.

5678. (*Chairman.*) There is no malting on the pneumatic system carried out so that the products of combustion do not reach the malt?—No, I do not think there are in our part of the world. In Germany it is.

5679. In Germany the pneumatic system is carried on and finished without exposure to the fumes?—I believe so, but I do not think that process would answer in England. We could not produce the malt that the brewer would like, there would be no finish to it. I have never seen any of the malt I have seen made in Germany which would suit the London or Burton brewer at all.

5680. Why not? Does not it make good beer?—A different class of beer altogether.

Fumes of k needed for flavour of English be

5681. You do not approve of German beer?—I like it very much, but it is a different class of stuff altogether.

5682. (*Mr. Cosmo Bonsor.*) The flavour of malt comes from the kiln drying?—Yes, altogether, and it is in the finish that the value of malt is ascertained.

5683. (*Chairman.*) In the German beer produced by this pneumatic system without exposure to the fumes of combustion, there is not at all the same flavour?—Not at all, it is a different thing altogether.

5684. Bavarian beer and Vienna beer are made of malt kilned in the same way that we do it in this country?—No.

5685. Are they supposed to be made of malt not exposed to the fumes of combustion at all?—I believe so in most cases.

5686. And lager beer?—I believe so, but I am no authority on that subject.

5687. (*Sir William Church.*) By exposing it to higher temperature, could not you get the same charring in the cylinders you do from the direct fumes?—Are you speaking of malt dried on the kiln?

5688. I am speaking of malt dried in cylinders like German malt?—I have never seen any successful operations in that way, and I have seen a good many.

5689. The peculiar flavour of English malt is not due to a charring of the malt itself, but is due to the actual addition of the flavour from the fume?—I think so, I should put it that way.

5690. (*Chairman.*) Is there any flavour from anthracite?—Not that I know of.

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5691. We know the peat reek in Scotland where the flavour is distinctly different?—Yes.

5692. (*Sir William Church.*) If it is only obtained from charring of the malt that would be a matter of regulating the temperature in the cylinders?—Yes. Anyhow the malt dried in cylinders, and not exposed to the fire is at the present time thought to be of no use.

5693. That I follow; but I wanted to know whether you could give us any evidence that that was due to alteration in the composition of the malt itself, or due to the addition to the malt of something obtained from the fuel. For instance, with wood you must get a good deal of what are called empyreumatic oils added?—I have no knowledge of that.

5694. What wood is used chiefly for brown malt?—Hazelwood, ordinary faggots kept for some time.

5695. Are any woods excluded?—No.

5696. When you say hazelwood you mean merely ordinary underwood, faggotted?—Yes, it is a different class of malt altogether.

5697. (*Chairman.*) And the beer has a different class of flavour?—Absolutely. I do not know of any way of drying pale malt with wood.

5698. (*Sir William Church.*) I am wanting to see whether the flavour of brown malt is added by the fuel or by the methods in which the malt is made?—No, by the fuel solely.

5699. The flavour of it is produced by the fuel?—Certainly.

5700. Therefore the flavour of the pale malt to a certain extent is produced by the fumes of the anthracite coal or the coke?—I should say so certainly.

5701. Do you exclude fir for instance from the wood you burn?—Yes, we use nothing else but hazelwood.

5702. Hazelwood is distinct from ordinary underwood?—We have to have it as we get it pretty well.

5703. You do not use particular wood? Beechwood would contain a much larger amount of substances like creosote than really nut wood?—Yes; we buy it as well as we can.

5704. Hazel is the trade name for it, but it is an underwood?—Yes, it gets a mixture of other stuffs in with it.

5705. You would exclude fir?—Yes, we should; we could not get it to begin with.

5706. (*Chairman.*) Would you object to it if you had it?—I think very likely we should.

5707. (*Mr. Cosmo Bonsor.*) Have you ever tried it?—No, I have never tried it.

5708. (*Chairman.*) Is there anything else that occurs to you besides what you have told us?—I do not think so.

5709. (*Sir William Church.*) You said the trade was upset rather by this scare, but you would think that it was improper that such an amount of arsenic should be aded by the fumes of coke as to produce considerably more than one-twentieth grain of arsenic in a gallon of beer?—I cannot think there is any arsenic in malt to cause any harm.

5710. It has been shown that the beer brewed with malt alone without glucose in it, one sample especially contained as much as one-seventh of a grain per gallon?—There may in some cases be a very bad piece of coal or coke which may produce that, but I do not think generally it can happen so. There is no devilry of any sort or description in the manufacture of malt, everybody tries as far as I know to produce the best article he can. There is no trick in the trade.

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5711. But no one was aware until quite recently that the use of gas coke opened up this?—It has been always used and in some places nothing else. In the North and Midlands they never used anything else for years. In Burton where they make the finest malt, and are supposed to make the finest beer, they never used anything else for years.

5712. I believe they used oven coke a good deal at one time?—And gas coke, too.

5713. Gas coke was not so abundant once as it is now, and we have it in evidence that oven coke contains very much less arsenic than gas coke?—I believe that is so.

5714. You yourself say you would use oven coke?—I should in preference.

5715. Do you think there is no danger when where gas coke is used without any restriction?—I think an inferior gas coke would be very likely detrimental. I think inferior coal would be also detrimental, there is no good in using it, and if you prohibit it it would be a very good thing.

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5716. (*Chairman.*) It has been suggested that gas coke from one district in England was practically free from arsenic, but that in another district the ordinary gas coke contained a good amount of arsenic. Have you experienced anything like that?—No; we use nothing else but anthracite coal in our district.

5717. (*Dr. Whitelegge.*) In what way do you suggest that a standard ought to be fixed?—As anthracite coal cannot be guaranteed free from arsenic absolutely, I would suggest some standard of limit which the maltster may work to.

Maximum quantity of permissible arsenic in malt should be officially fixed.

5718. A standard of anthracite coal or a standard of what?—Arsenic.

5719. Arsenic in the malt or in the coal?—In the malt. I do not think you can produce malt absolutely free from arsenic for the very good reason that coal is not absolutely free.

5720. Would you not agree that it is desirable to exclude even the least trace of arsenic that can be done?—I do not think it could be done.

5721. Would it be desirable?—Certainly; but I do not think it can be.

5722. If there is a variety of anthracite coal free from arsenic, would you agree that it is preferable to use that rather than an anthracite coal containing a little arsenic?—Certainly.

5723. Would there not be danger, if a standard were introduced, of suggestion that it was immaterial whether the arsenic below that minimum were excluded or not?—No; I do not think so.

5724. Do you think it is necessary for maltsters who use anthracite coal to examine for arsenic?—I do not think it is, if you ask me, although we do it now.

5725. If there were a standard, what would you propose the maltster should do? Test his malt from time to time?—We do that now.

5726. But not to give any special attention to the coal?—No, certainly not; he might have it analysed to start with.

5727. Have you any suggestion to make as to the amount of arsenic that should be specified on a standard if any were specified?—I could not say that, but I think you can produce malt if dried by good anthracite coal, practically free from arsenic. I do not think you can guarantee it—that is my point.

5728. What would be the object of the standard—to enable the maltster to give a certificate that the arsenic did not exceed a given standard?—Precisely.

5729. (*Sir William Hart-Dyke.*) You mean you can guarantee the standard, but you have a difficulty to guarantee an absolute freedom from arsenic?—We are advised that we cannot get it absolutely free.

5730. (*Mr. Cosmo Bonsor.*) If some public authority were to settle the standard, do you think every maltster could keep practically below it?—Yes; that is what I think should be done—that is my point.

5731. (*Chairman.*) Your own chemists could test it and keep it out at the right time?—I think so. We continue to have our malts analysed for arsenic from time to time, and we endeavour to keep within that standard.

5732. (*Dr. Whitelegge.*) And always with negative results. You told us that the malt samples had never been found to contain any arsenic whatever?—I was only quoting my own instance.

5733. The malt had been frequently examined and you never found arsenic?—Yes, we were at it every day. We are asked to guarantee malt and keep it free from arsenic.

5734. (*Chairman.*) What quantities of malt are taken in the chemist's test?—A very small proportion.

5735. Have you thought of having a still more searching test of a larger quantity?—No.

5736. Do you think that the freedom from any trace of arsenic in the samples you gave is practically sufficient?—I think so, certainly. I do not see how you can do it in any other way. In our own business we are endeavouring as far as possible to work within those lines.

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5737. (*Sir William Church.*) Do you know what quantity your analyst uses in the sample?—No, I do not.

5738. You do not know whether he examines half a pound or a pound?—I could not tell you. I should think less than half a pound.

5739. (*Chairman.*) The quantity tested is of very great importance?—The sample is drawn from a large bulk of stuff, a thousand quarters of malt. We draw a sample from the bin, and an average sample is sent up to be analysed; we can do it in no other way.

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5740. But the quantity the analyst actually uses would be of great importance?—I do not know what he uses, but I should think less than half a pound. It is a very small quantity.

Method of sampling malt.

Mr. CORNELIUS O'SULLIVAN, called; and Examined.

Mr. C. O'Sullivan.

5741. (*Chairman.*) You are a Fellow of the Royal Society?—Yes.

5742. And you undertake the scientific and chemical work for Messrs. Bass and Co.?—Yes, at Burton-on-Trent.

5743. You have some information to give us on certain points we are enquiring into?—Information has been asked of me on the following points:—

(1) As to precautions which in your Burton experience have, in view of recent events, been considered necessary or desirable, to guard against the introduction of arsenic into beer, by any ingredient (sugars, malts, etc.).

(2) How far, in your experience, it has been found practicable to eliminate risk of introduction of minute quantities of arsenic into beer; and

(2A) Any other matters within the reference of the Commission.

In reply thereto I may say:

(1) When it became known, through the daily papers, about the 23rd of last November, that arsenic was found in some beers, although the source whence it was derived was clearly indicated, it was deemed desirable, as a precautionary measure, by the Burton brewers, in common, no doubt, with the brewers all over the country that every source by which arsenic could be introduced into beer should be carefully examined; and, as the sugars of different kinds, employed as malt substitutes, were the sources chiefly implicated, at least to begin with, the use of these was discontinued in most cases, at once, although examinations have since shown the precaution unnecessary; the sugars, as a rule, have been found free from arsenic, or at least practically so. Further, it was considered desirable that all beers in stock should be examined by the local staffs and by outside authorities. Burton brewers have, as a rule, competent chemists on their staff, and those who have not employ such men outside. The general results were that the beers were declared practically free from arsenic. But when developments took place, and when the academical side of the question took the place of the practical one, it was found there was yet something to learn as to the presence of minute quantities of arsenic in beer and as to the sources thereof. It was observed that in some of the beers these minute quantities of arsenic were greater than in others. The cause of this was enquired into, and it was soon established that malts dried with a proportion of gas-coke contained much more arsenic than malts dried with a proportion of oven-coke. These facts were confirmed by outside observation. The use of these malts was at once discontinued, and as a further precautionary measure, even oven-coke was, as a rule, discarded and the cleanest anthracite alone employed. For many years Burton brewers have used little or no gas-coke, for the simple reason that it imparted a smoky disagreeable flavour to the malt, which was carried to the beer. Of course, as far as practical, they bought no such malt. But, inasmuch as outside maltsters recognised this fact care was taken by them to eliminate the flavour by selecting the gas-coke they employed so that in most cases it was impossible from the odour alone to distinguish gas-coke dried malt from any other. It appears, however, that the selection of the non-flavour giving varieties of gas-coke did not also eliminate the arsenic-containing ones. Hence, it was deemed desirable to discontinue the use of all outside malts, until they were tested and found to be practically free from arsenic.

Minute quantities of arsenic in Burton beers attributed mainly to coke-dried malt.

Use of gas-coke discontinued.

All these precautions notwithstanding, it was still observed that all the beers were not absolutely free from arsenic, when the rigorous test was applied; quantities varying between 1-100th to 1-500th grain per gallon and practical purity were certified to by competent authorities. I may mention, as an example, that I have had examined by a leading authority, with whom our own observations are in broad agreement, 32 samples of different beers, the products of some of the chief breweries of England, Ireland and Scotland, and of Holland, with the results that they contain quantities of arsenic trioxide, varying between 1-50th of a grain per gallon and practically nil.

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The nil samples amount to 3 in the 32, and I believe two of these are part sugar beers, or beers brewed with part grits, made from flaked maize or rice.

This being the case, the cause of it and the means of obviating it had to be sought for. An examination of malt dust, i.e. the dust obtained on screening and fanning the malt after the grosser rootlets had been eliminated, showed that it contained much more arsenic than the malt itself; hence it has been decided to put up apparatus containing brushes and screens of the highest efficiency. They, I believe, will still further reduce the infinitesimal quantities of arsenic in beers, but I cannot hope that they will be, thereby, absolutely eliminated.

Arsenic reduced by brushing.

Hops have also been carefully examined, and although many growths have to be rejected in consequence of the large quantity of free sulphur they contain, very few samples have been found to contain arsenic, in fact, they may so far be said to be absolutely free. As, however, sulphur washes are used during their growth, as they are frequently treated with free sulphur when maturing, and as sulphur is used in the kiln fires during drying, it would not be surprising if hops, too, will on further investigation be found to supply their quota, however small, of arsenic to beers. This is also a contingency against which brewers will, of course, have to guard.

Hops also free from arsenic.

(2) I have indicated above the precautions taken which were considered desirable with the view of eliminating the risk of introducing even minute quantities of arsenic into beers and partially the results that might be expected. All the precautions taken have, I believe, led to a large diminution, but I cannot say that they have, so far, effected complete elimination in all cases.

I believe it can be shown that beer must have contained minute quantities of arsenic from time immemorial, but I believe there is no evidence that any effects, injurious to health, attributable to this quantity of arsenic, has so far been recorded. Methods for the detection of arsenic in beer are given in analysis books, but it is fairly clear that this arsenic is supposed to be introduced by accident or malicious intent.

Beer must have contained from time immemorial.

I do not wish to deal with the methods of determination of minute quantities of arsenic. I may say, however, that I believe they are in some hands broadly satisfactory, as far as they go, but I am strongly of opinion this matter should be treated as the water commission treated the pure water question, that is, institute an enquiry into it with Governmental authority, so that practical methods may be established and uniform results insured.

(2A) Should there be any other points within the reference upon which the Commission may wish to examine me, I shall, in duty bound, be glad to give all the information within my knowledge.

5744. (*Sir William Hart-Dyke.*) I suppose you naturally, in common with all those connected with this trade, took great alarm when the news became known of this epidemic at Manchester?—I do not think I would admit the word "alarm." We certainly became nervous at the matter, but inasmuch as from time immemorial we have never observed any evil effects from the use of moderate quantities of beer we did not feel that as far as we were concerned, especially considering the materials we employed, there was very

much to fear, or at least that there was anything to be alarmed at.

5745. Were you in the habit of using glucose in any shape?—Yes.

5746. Could you tell the Commission in what proportions you used it?—Taking it all and all probably about 2½ per cent. upon the malt.

5747. The rest being malt?—Yes.

5748. And what steps did you take for the future security against poisoning?—We immediately examined the glucose as a preliminary step, and then, lest in the past, not having examined the glucose, any of the stock might have been brewed with arsenical material, the beers that had already been produced were carefully examined until they were declared free. That is as far as my firm is concerned, but I think I am speaking broadly for the district of Burton-on-Trent. I think it would be scarcely fair to speak only of my firm. I would have it understood I am speaking for the brewers of the district as far as it is within my knowledge.

5749. Burton brewers have competent chemists on their staff?—Yes, and the smaller brewers employ outside men.

5750. They would call them in for emergency or on occasion to do the work?—As a fact, probably two or three of the smaller brewers have certain consulting brewers and chemists in common. They fee them by the year and on the amount of analysis they do afterwards. So that they are really and practically quite safe.

5751. (*Professor Thorpe.*) You mean they have a retaining fee?—Yes.

5752. (*Sir William Hart-Dyke.*) The general results in the initial stages of your enquiries for arsenic were good?—As far as the methods of analysis at first employed were concerned, the declaration by ourselves as well as by one of the best analytical chemists in England were on the side of practical, if not absolute purity.

5753. Later you found, did you not, some change took place with further developments?—That is so.

5754. Could you tell the Commission a little more as to what steps you took then?—It was then of course necessary to discover the sources from which these minute quantities of arsenic were introduced into the beer. To begin with I may say it was very difficult to satisfy ourselves they did exist there. However, as time went on there was no difficulty in establishing the fact, and then it was necesary to determine from what source these traces were derived. The different varieties of malt employed were examined, and as a broad fact it may be stated that the malts which were imported from outside sources showed a larger quantity of arsenic than those produced in the town itself. Therefore from the effect to the cause was a very short step. Enquiry showed that most of the bought malts were dried with gas coke, or partially with gas coke, and as a rule that the malts made in the town were dried with anthracite and oven coke, anthracite being used in larger quantities probably than elsewhere. Hence it was a fair conclusion that the source of the arsenic in the malt was the coke. The brewers therefore making their own malts rejected the coke altogether, and used nothing but anthracite.

5755. (*Chairman.*) Formerly they had used gas coke and oven coke?—In some of the firms of Burton-on-Trent I believe gas coke was used to some extent, but I cannot say it was used to any large extent, because the flavour of gas coke beer, unless the gas coke is very carefully selected, is objectionable.

5756. (*Sir William Hart-Dyke.*) Smoky is it not?—Quite so.

5757. I suppose, generally speaking, as regards the breweries with which you are connected, your opinion is that if mischief were to arise it would come from the use of gas coke?—It would be very difficult to say that altogether because we have no definite experience, and we have no definite evidence as to what variation may take place in the composition of anthracite or in the composition of oven-made coke. It would be almost impracticable to answer your proposition at the present time.

5758. You think there would be greater security in the use of anthracite than in oven coke?—I do not think there is any large amount of evidence for that at the present time; I believe oven coke can be got quite as clean as anthracite. I have found large quantities of malt made from mixtures of oven coke and anthracite quite as pure as those made from anthracite alone.

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5759. Given the three species of fuel, anthracite, oven coke, and gas coke, if you are asked to eliminate from those three the most dangerous, you would eliminate gas coke?—Yes, certainly. And I think the evidence at the present time so far is against oven coke too, and is strongly favourable to anthracite, but the time at the disposal of those persons who are investigating the question has been so short that the quantity of evidence is not sufficiently great to come to any absolute decision on the point.

Oven coke and anthracite compared.

5760. You say for many years the Burton brewers have used little or no gas coke on account of this smoky disagreeable flavour?—That is so.

5761. You said outside maltsters recognise this fact, and action was taken by them to eliminate the flavour by selecting the gas coke they employed so that in most cases it was impossible from the odour alone to distinguish gas coke dried malt from any other?—I believe that is really so.

5762. But that the selection of a known flavour-giving varieties of gas coke did not altogether eliminate the arsenic containing varieties, and therefore it was desirable to discontinue the use of all outside malts altogether?—That is so in my experience. Practically the outside malts, malts that have not been made by ourselves, are not used at the present time except in probably two cases in which the malt is found to be absolutely free, and these malts are also known to be anthracite dried malts.

Gas coke suited for flavouring not necessarily satisfactory quâ arsenic.

5763. You have had a large number of samples of different beers tested, have you not?—Yes.

5764. You said "by a leading authority." Could you tell us more about the application of the test and give the authority?—Do you think it is necessary, sir?

5765. (*Mr. Cosmo Bonsor.*) Was it the Marsh test of the Reinsch test?—The Marsh test, the Berzelius Marsh. He used sulphuric acid in greater part with a little nitric acid so as to eliminate as much as possible the organic matter. I will tell you, if you wish, that it was the firm of Calvert and Thomson of Manchester.

5766. I think they have made testing for arsenic rather a special part of their business?—As far as I know Mr. William Thomson has had a great deal to do with the testing—at least I have it from hearsay that he has had a great deal to do with the testing for minute quantities of arsenic in cloth, carpets, and such things, because it is said there are some countries, for example, Norway and Sweden, where they will not allow a carpet introduced into the country containing more than 1/600th of a grain of arsenious acid to the square foot. I do not give it upon my authority; I have only heard it said.

Arsenic in carpets.

5767. (*Chairman.*) Mr. William Thomson has been testing for carpet manufacturers?—That is my information; I have been so informed.

5768. How was the arsenic supposed to get into the carpets?—By the dyes, I daresay.

5769. (*Sir William Hart-Dyke.*) You say out of all these 32 samples, those containing none whatever were only three?—That is the report.

5770. And that two out of those three were beers in the composition of which sugar has taken a part?—That is the inference in consequence of the breweries from which they are derived.

5771. They came from breweries in which sugar is used?—Yes, where it is used as a malt substitute.

5772. From breweries in which in no case malt and hops alone are used?—That I cannot say definitely, only they are known as breweries in which sugar is used as a malt substitute.

5773-4. (*Sir William Hart-Dyke.*) The largest quantity found per gallon was 1/50th of a grain?—Yes, that is so.

5775. Have you taken some trouble to examine malt and malt dust or combings?—We have examined the malt dust and the malt itself; by the dust, I mean the matter still adhering to the grain after the rootlets or combings are screened out. It is capable of being detached by abrasion, and, as a fact, when even well-screened malt is moved about in sacks, a considerable quantity of it becomes loose and can be separated by

Arsenic in malt dust.

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screening and fanning. It was in the dust thus obtained I found much more arsenic than in the malt itself.

5776. When you say "dust" you are referring to the dust and rootlets, the result of the screening process?—I am referring to the dust obtained by abrasion after the rootlets have been separated.

5777. You said "examination of malt dust," that is the dust obtained on screening and fanning the malt after the grosser rootlets had been eliminated?—Yes, the grosser rootlets formed by the germination of the seed are broken off by machinery and separated by brushes and fans and by screens, and then the malt still contains matter which is capable of being removed from its coating by abrasion. That matter is the dust which I say was examined and found to contain more arsenic than the malt dust itself.

5778. (*Chairman.*) Was the portion of the dust containing the rootlets also examined for arsenic?—I have not examined them nor have I had them examined, but I should say that they would be as likely to contain arsenic upon their surface as the malt itself.

5779. (*Sir William Hart-Dyke.*) You say you decided to increase the efficiency of this process?—Yes, we are putting up, and I believe most of the maltsters in England are putting up, brushing, fanning, and screening machines, so as to attack this small quantity and eliminate as much as possible the removeable dust, at a very considerable expense, too.

Arsenical malt which cannot be sold at present time.

5780. That is your experience of the trade at present?—It is within my knowledge in certain cases, and I have it from hearsay in many others. There is no doubt that many of the maltsters in England have malt on their hands at the present time that they cannot sell, and everything is being done to eliminate the quantity or the proportion of arsenic that may be considered detrimental to the malt. That is absolutely within my experience.

5781. The presence of arsenic in malt at all or in this dust after screening has come as rather a surprise to the brewing trade and malting trade?—Absolutely as a surprise.

5782. There was no suspicion of it before?—Not a suspicion to my knowledge.

5783. (*Chairman.*) I gather that some maltsters have on hand malt they are not able to get quit of, is that because of arsenic?—So I am informed.

5784. Before the scare it would have passed as a matter of course as good malt?—Certainly.

5785. Do you know at all how much arsenic there was in any of that malt?—I should not like to say, but in some cases probably as much as 1/100th of a grain to the lb.

Proportion of malt in all-malt beer.

5786. (*Mr. Cosmo Bonsor.*) What would that show in beer?—Taking 3lbs. of malt to the gallon of beer, which is a little above the average gravity, it would bring it down to 1/33rd grain per gallon.

5787. (*Professor Thorpe.*) That assumes it all went in?—Quite so. I should not like to assume it for the moment though.

5788. (*Sir William Hart-Dyke.*) Have you any other suggestions to make beyond the care with regard to screening?—I do not really see that any other is necessary. I have made experiments by carefully brushing malts that I knew were moderately contaminated, contaminated probably as high as 1/100th grain to the lb., and when these malts were properly brushed, brushed as efficiently as the machines being put up can brush it, they were practically free from arsenic. I do not mean to say that if a man took 5lbs. of it and got it down by hydrochloric acid and chlorate of potassium he might not get a mirror in the Marsh's apparatus, but for all practical purposes I am perfectly sure that malt would be free from arsenic.

Malt can be rendered practically free from arsenic,

by careful cleansing.

5789. To your mind the real solution of the difficulty and the way to get security for the consumer of beer in the future, is to have this malt practically and thoroughly dealt with by a cleansing process?—That I believe is the practical way out of the difficulty at the present time.

and selection of fuel.

5790. The fuel question is of course one of the most important elements?—As a matter of fact, there is no evidence so far that any arsenic carried into beer through the malt is derived from any other source than from the fuel. That may be taken as a fairly approved fact, I think.

Mr. O'Sulli

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Difficult prohibit of gas c by malt

5791. Would you suggest that if it were proved either through this enquiry or otherwise that gas coke is far more liable to cause the presence of arsenic in malt, it would be necessary to go so far as to forbid the use of gas coke for malting?—The difficulty in my mind would be how to prevent it, because if coke at all were used you could not put the key upon the gas houses or upon the malt houses, and it would be very difficult to prevent it going in. You would have to get a good many people to watch it to handle the matter in a practical way.

5792. But do you think that, considering all that has happened, the malting trade as a rule would use their utmost endeavour to protect the consumer of beer and are now inclined to use anthracite or oven coke as much as possible?—I am perfectly satisfied that there is no maltster in Britain who is not doing everything he knows to eliminate the traces of arsenic that his malt may contain, and that therefore if it is thoroughly impressed upon him that there is any risk of the introduction of arsenic by the use of any fuel, he will spare no trouble to eliminate that fuel. It is a very serious loss to the maltsters of this country at the present time to have the amount of malt I hear they have on their hands, and cannot sell or handle in any way unless some means is devised to eliminate a considerable quantity of the arsenic. Therefore to prevent any possibility of that loss of money in the future they would take every precaution that could be possibly taken or they could be helped to take by the scientific experts from outside.

Arsenica malt—lo to maltst

Removal arsenic b brushing

5793. (*Chairman.*) The malt they have in their hands could not be purified by any rigorous process of brushing?—I think I have said I feel quite satisfied that with the systems of brushing that are being devised the larger quantity of the arsenic will be eliminated.

5794. And has that been tried, do you know, on the stock in hand they have so much trouble about?—I believe it has to some extent, but it takes a considerable time to have these brushes made and there are only a certain number of men in the country who have the apparatus for making them. Therefore it takes a considerable time before they will be in proper use. I feel inclined to think myself that, except for the stock of malt that is on hand, by the time they are erected they will be absolutely unnecessary, that the malt dried by anthracite will be sufficiently free for all practical purposes.

Distribut of arsenic coal prob very uneq

5795. In the public interest would you think it would be advisable to have a rule about the fuel used, that it must be arsenic free, or would you let the rule for the security of the public be, that there is not to be arsenic in the malt, or the double security that the fuel is to be arsenic free and the malt arsenic free?—As far as any security of the fuel being arsenic free is concerned, I believe it is a proposition outside the range of practical politics, so to say. It is out of the range of practicability. You get a seam of coal 100 yards in length and take blocks out of different lengths of that seam, and examine it for any one of the constituents. I have had to do it for the amount of chlorine that the seam of coal may contain, and I found that the variation was considerable. If, in the case of one constituent, I ask why not in the case of the other? I do not say it has been done for arsenic, but I have not the least hesitation in saying that what holds good for one small proportion of a thing will hold good for the other, and the seam of coal examined its whole length will not show identically the same quantity of arsenic. And I believe if it did we have no methods at the present time sufficiently accurate to determine that point to satisfy all conditions, because I maintain that colour tests, tests by comparison although right enough in their way, until one can weigh and measure—and these are only correct within certain limits—one cannot be satisfied that there is any real security with regard to accuracy.

Beer can rendered absolutely free from arsenic.

5796. (*Sir William Hart-Dyke.*) With all the precautions human ingenuity can devise you think there is always a possibility of there being some arsenic in the beer that is drunk?—I should not like to say that. I think I have been able to prepare a beer that was absolutely free from arsenic, and I have plenty of beers certified to be absolutely free by even the most rigorous test.

5797. (*Professor Thorpe.*) Do you consider that preparation of such beer involves the same order of difficulty as making a chemically pure chemical?—Quite in that same order.

5798. (*Chairman.*) Your remarks about fuel apply to anthracite. You think there may be arsenic in some specimens of anthracite, and not in others from the same bed?—That I must admit.

5799. The employment of sugar or glucose as malt substitutes was discontinued?—Yes, as far as most of the breweries in my district are concerned, it was discontinued as malt substitute. In the question of malt substitutes in contradistinction to any other use that sugar is applied to, I may say the malt substitute is intended to displace a certain quantity of the malt. It is used in the copper and boiled with the wort. That is the sugar used as a malt substitute. There is a small quantity of sugar solution-glucose or cane sugar being employed as priming, and added to beer after fermentation. This I do not include under the head of malt substitutes.

5800. What you refer to now is sugars used for priming?—Yes, glucose, and some brewers use well crystallised sugar candy.

5801. That would just sweeten the beer?—The quantity used would be so infinitesimal that it does not enter into the question. If you take it that probably there would not be much more than 1½ per cent. upon the extract, in some small breweries it may go up to a great deal more than that, but in those breweries where it is really looked upon and introduced as a priming it does not exceed 1½ per cent.

5802. If there is any arsenic in the priming that all remains in the beer?—Yes, certainly, except it should be eliminated by the after fermentation, by the yeast taking up any portion of it.

5803. But the priming is applied to beer, the whole of which is put into barrels?—Quite so.

5804. So that it would be only by depositing in the barrel that any of the arsenic could fail to be in the beer?—That is so.

5805. You found afterwards that the giving up of the use of the sugars was not necessary?—That is my experience at the present time, the sugars on the market are practically if not absolutely free from arsenic.

5806. Would you still approve of those sugars being used in the two ways, both as malt substitutes and as priming?—I do not say I would approve, but I would have no objection.

5807. In high class beers is sugar used as priming?—Yes, certainly.

5808. And in the lighter class of beers, which I suppose were chiefly concerned in the epidemic, would there be glucose in the priming there, or in the brewing, or both?—In both.

5809. And a large quantity of it?—In the brewing, as the malt substitute.

5810. But a small quantity in the priming?—About the same as usual, I should say.

5811. In the beers you speak of when the use of the sugars was given up, was the quality of the beer sensibly altered?—I should say not really, in my own experience. I have heard some men say since they had to give up a certain small quantity they did not get the fineness of flavour, and had to use the better class of malt.

5812. And then they get the good quality in the beer?—Yes. That is putting the facts broadly.

5813. So that the use of glucose not only renders a smaller quantity of malt necessary, but allows of an inferior quality of malt being used?—I do not quite understand the question.

5814. I think you said that when they gave up the glucose, they were obliged to use a higher quality of malt?—That is so, and to displace the quantity of sugar by a quantity of malt equivalent to it.

5815. When you say a "higher quality of malt" in what respect was it of a higher quality?—That would be rather difficult to describe I must confess. Some brewers think that the malt they have to give the highest price for is the best malt. Others are satisfied if it gives a beer sufficiently good for their purposes. The question of real goodness is one of those things which it is very difficult to decide.

5816. Has the customer much to say in the matter, or the publican who sells to the customer?—I think, as a broad fact, he has pretty well everything to say on the matter. His tastes have to be very materially considered, and if they are not, he soon lets the brewers know. If one brewer, for example, in the town is sending out beer that is unsuitable to the tastes of the beer-drinking part of the community, and the other brewer is sending out beer that is suitable, the brewer who is sending out the latter, will have the advantage in a very short time.

5817. We were told that some brewers before the scare gave up the use of glucose so as to have an all-malt beer, but that their customers did not like it so well, and they were obliged to go back and use the glucose?—That may be said, and probably it is true, but I hardly believe the point, taking it altogether. It was because the beer did not suit the customers that they had to go back to the use of glucose. I admit this fact; there is a certain luscious flavour in invert sugar, and also certain flavours in some of the glucose which are imparted to the lighter beers. When people get accustomed to these flavours they will not have anything else, so that I do not say it is quite an impossibility that a brewer going from sugar to malt may not be forced back to sugar again by the taste of his customers.

Character of beer may depend on local taste of public.

5818. That may be a perfectly healthful taste. The use of glucose does not make the beer less healthy, while making it more agreeable?—Certainly not. So long as it is a purely manufactured article, I cannot see that it is at all.

5819. Have you any analysis showing the quantity of arsenic in sugars referred to when you said that sugars as a rule have been found free from arsenic, or at least practically so?—At the time when these sugars were examined attempts to express such quantities as a 1-100th of a grain to the lb., or a 1-200th of a grain to the lb., or indeed, even 1-500th of a grain to a lb., seemed to be an absolute loss of time. It seemed to me at that time impossible to give a number when the quantity went below 1-20th of a grain to the lb. One may then form some idea that it did contain at least 1-20th, but one could not be sure of that. When, however, it went down to 1-200th or 1-300th of a grain to a lb., it was absolute guesswork, and I should say when it required, say 200 grammes or 300 grammes to establish definitely, there was some arsenic there, it may be altogether neglected, although it may have been put down as 1-300th to a lb.

Estimation of minute quantities of arsenic largely guesswork.

5820. But you would say now 1-300th of a grain to a lb. might be measured?—A fair guess might be made at it. For example, I believe if it were put in the hands probably of three different men, and even men working upon the same lines, that one might very easily return it as 1-200th of a grain to a lb., and the other 1-300th of a grain to a lb., and the other 1-400th of a grain to a lb. I believe that is the condition of things in which the determination stand at the present time.

5821. Even by the most careful and well-skilled analysts?—I believe that is so.

5822. You have used the Marsh test, I think you said?—For the smaller quantities.

5823. Do you find it is more trustworthy for the smaller quantities than the Reinsch test?—I may say that I agree broadly with Professor Stevenson upon that point that in the hands of a man who knew how to work the Reinsch test, if the man had the concentration sufficiently right, and his copper sufficiently right, and the mode of sublimation, which is the real crux of the question, under the proper conditions, I believe he need not miss 1-200th of a grain to a gallon in beer. I am perfectly satisfied he could show crystals of arsenious acid from a beer containing 1-200th of a grain to the gallon. But when it goes beyond that, and one has to concentrate, and the amount of organic matter in the solution is great, the deposit on the copper is not so regular, and one cannot rely on it so well as in the case of dilute solutions. Hence when it goes beyond 1-200th of a grain per gallon, it is rather difficult to get copper that will yield crystals with any degree of satisfaction.

5824. We have been told that sometimes the copper keeps some of the arsenic, and the sublimation is not complete: is that consistent with your experience?—I have never tested the question really. When one considers the analysis of electrolytic copper, and sees quantities down to 1-100th per cent., one would not be surprised that if arsenic gets near copper at all under any conditions the whole of the arsenic would be given up again.

5825. Have you ever tried deposit on platinum foil by electrolytic action?—I have not.

5825 (*Professor Thorpe.*) The arsenic which is present in the coal, and of course incidentally in the coke, is probably associated with the sulphur and the iron?—I think most likely.

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5827. That is to say, it would be present in what are called the coal brasses?—Yes, most likely, in the pyrites and the marcasite. Of course the pyrites vary very considerably in composition in the different coals. One kind would contain one variety of pyrites, and another another variety.

Form in which arsenic present in coal.

5828. But the pyrites itself if it were detected would be a significant thing to look for, and to avoid, so to say, in the selection of the coal?—I should say as a practical test for the suitability of the fuel required that the presence of any shining crystals or scales of pyrites would be very practical and important indication that the seam of coal, or the portion of coal that contained these traces, should be certainly rejected. I cannot say but it would be to the interest of the maltster to look for them.

5829. In the selection of any coal one might, so to say, keep off arsenic by keeping off coal brasses?—The evidence probably is not altogether quite satisfactory upon that point yet, but I believe in the main it may be taken as true. If you take a piece of coal and cut a cubic inch out of it, which appears to be all carbonaceous matter, I am not quite prepared to say that that block of coal might not contain some arsenic, but I am prepared to say that all other things being the same, coal showing the faces of either scales or crystals of pyrites are coals that will certainly yield the greater quantity of arsenic. I believe that is the point.

5830. That is what I want to get from you. But that method of selecting coal for industrial purposes is already in use?—I have heard so.

5831. The iron smelter, for example, in taking coal for his particular use will select it with the view to the avoidance of pyrites?—That is so.

5832. That presents no industrial difficulty?—No.

5833. Oven coke for the same reason I presume is less free from pyrites, because it is selected in view of a special purpose?—Quite so. There is no other possible reason that it should contain less.

5834. It has been selected for the absence of sulphur?—Yes. One of the curious things when one comes to consider the matter, is why it should contain any at all. Imagine the high temperature of the coke.

5835. It has probably been converted into other forms in a reducing atmosphere?—That is quite so.

5836. What is the difference in price between gas coke, oven coke, and anthracite?—I cannot say.

5837. Is it a factor which is at all likely to enter into the calculations of a maltster?—Certainly it must enter into the calculations of the maltster, otherwise he would not go to the trouble of using gas coke.

Price of malting fuel.

5838. It is not the convenience of its being on the spot?—That may have something to do with it. I am speaking without the book, but with a certain amount of knowledge on the matter. You may buy gas coke in the town in large quantities at 13s. a ton, but I think at the present time probably you would have to give for oven coke 22s. or 23s.

5839. And for anthracite in your district?—Probably 23s. or 24s. I am speaking without the book, but it is sufficient for practical purposes. You may take it broadly that gas coke is materially cheaper than oven coke, and oven coke is somewhat cheaper than anthracite.

5840. As you put it, anthracite is double the cost of gas coke?—Yes.

5841. How far does the cost really enter into the production of malt?—I am afraid upon these matters, upon the commercial aspect of the question, I have very little knowledge. I neither buy nor sell anything connected with the trade except some very small things.

5842. The object of my question was how far any restriction as to the use of fuel was going to enhance the price of malt?—I think you may put it down that it will certainly enhance the price of malt. The alterations which have taken place already have put up the price of malt considerably; that is, of the available malt.

5843. (*Mr. Cosmo Bonsor.*) The cost of making malt, not the cost of the malt?—Yes, and of course the price, too.

5844. (*Professor Thorpe.*) In view of the greater stringency of purity required?—That is so.

5845. You told the Commission you think that by the time this brushing machinery is in general use the necessity of it will be very largely obviated?—That I believe is true.

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5846. Do you rather deprecate the brushing of the malt apart from this question of arsenic?—Not at all. As a brewer I think it is most desirable.

Brushing malt desirable apart from arsenic.

5847. (*Sir William Church.*) With regard to that question, would you be in favour of this brushing being done by the brewers or by the malsters; the last witness said he objected to the maltster brushing because he could palm off inferior malt?—I do not think the brewer would object to have the maltster do it, but I think, taking it altogether, he would prefer to have the brushing under his own control. There is one more factor in the matter. If malt travels any distance after it is brushed or screened there is yet still more dust eliminated by the abrasion of the particles.

5848. That would be a further safeguard to the public?—In consequence most of the better brewers have fans and screens immediately before the mills to handle such malts. In other words, I believe it is impossible to move the best screened malt without having a certain quantity of dust develop in the process of moving. The rubbing of the corn against each other; the passage of the corn from the stack into the hopper, and so on.

Should be done by brewer.

5849. You, speaking as a brewer, would agree with the last witness, a maltster, that the final polishing and brushing had better be done by the brewer than the maltster before it leaves his malting house?—Certainly, I think there is every reason for it.

5850. Can you tell me what the flavour of malt depends upon?—That is rather a big question.

5851. You heard, I think, the last witness's evidence?—To some extent. The flavour of malt depends upon many things. I have not prepared evidence on this point, but I have my opinions on the matter, and am quite willing to give them.

5852. At present, to meet the requirements of the brewer, the maltster has to allow the fumes of the fuel to pass through his malt?—I think you may take that as broadly so.

Malt might be given satisfactory flavour without exposure to fumes.

5853. Do you think that it would be possible to obtain that flavour in the malt without the presence of the fumes?—What you mean to ask me is, whether it would be possible to so far cure the malt without allowing the fumes or the vapours of the fuel to pass through it, that it would be as acceptable to the brewer for brewing purposes as it is at the present time. I cannot say that, taking it altogether, I have any reason to believe that it would not be possible to produce as good a malt, giving flavour by the passage of properly heated air without the products of combustion, as it would be by carrying the products of combustion through.

5854. So that its flavour really does not depend upon changes due to the fuel? You say you do not use gas coke because you wish to keep out a disagreeable flavour, but you obtain the flavour that you need in the other cases by the use of coal fumes?—That is why gas coke was rejected.

5855. But you are not prepared to say the other is necessary for giving the required flavour?—I should say not, certainly. I know of no flavour that, provided the air was of sufficient temperature and the amount of water in the malt when the temperature was employed was suitable, the roasting flavour could not be given to the malt with heated dry air as well as with heated dry air plus the products of combustion.

5856. (*Mr. Cosmo Bonsor.*) You would still want a draught?—Naturally.

Brown malt.

5857. (*Sir William Church.*) And the brown malt that is spoken of, which is dried by means of wood, is merely that you want a shorter and fiercer heat?—I have no experience with it, except that I see it now and then. It is offered to me, but I do not handle it. It is to give a certain sort of body flavour, and generally used in porter and stout.

5858. Still, if I might have your opinion, it might probably be because you get a shorter and fiercer heat from the wood than you do from the anthracite coal?—It seems likely, but I could not bind myself to an opinion.

5859. It appeared to me like that?—It appears so to me, too. There is no doubt that brown malt is what is known as blown, that is to say, a high temperature is applied to it while it still contains a large proportion of water, so that the water in the grain is volatilised by that temperature, and the skin of the grain blown

so as to be much expanded. If you get a sample of that malt, you will see that every grain of the malt is quite distended.

5860. Have you had analysed any of the combings?—No.

5861. You would not like, perhaps, to express an opinion whether they are likely to contain sufficient arsenic to be prejudicial to its use as a feeding stuff for cattle?—Under the ordinary conditions of drying, or even with use of ordinary gas coke, certainly not.

5862. You do not think that the use of the combings scattered over chaff and other things would be prejudical to stock?—I should say not.

5863. What quantity of malt would you propose should be used as samples for testing, an ounce or a pound or what?—A good deal would depend upon the bulk to be sampled.

5864. I mean what amount should the chemist work with?—Some of them can work with as low as 10 grammes.

5865. You can imagine that malt might contain arsenic, that is to say, not be absolutely pure, and yet it would be impossible to detect the presence of that arsenic in an ounce, while it would be detected in a pound?—If it is found by examining an ounce there is the least trace, a more distinct indication can be obtained by using 1lb. or 10lbs., provided the reagents are sufficiently pure.

5866. I was asking you, rather supposing you agreed with the last witness in thinking there should be a standard laid down that there should not be more than a certain quantity of arsenic in malt?—That I should say distinctly would be a desirable thing, but it should be laid down with Governmental authority. I have in my own mind now the condition of things when the Water Commission first sat, or when the Water Commission was working. I remember as well as possible that the idea of estimating the 1-10th of a grain of ammonia to a gallon was simply scouted; a 1-10,000th of a grain per gallon now all analysts can detect. So that if we were to lay down to-day a certain standard, unless the method by which that standard was arrived at was clearly and distinctly stated, what we call the 1-100th of a grain to a gallon to-day may turn out later on to be 1-10th of a grain to a gallon. I do not know whether the authorities will agree with me, but it is my experience on the matter.

5867. Therefore you would not propose there should be any definite standard?—Not without accurate and careful investigation by competent men. I believe that these minute quantities of arsenic in all articles of food as well as in beer, malt, and so on, is a problem at the present time well worth investigation. It should be submitted to that investigation, and the results of it should be stated authoritatively. Then it would be for the doctors to say whether or not any quantity that could be determined by this method should be allowed.

5868. Given a definite amount and a definite method of working, what would be a convenient quantity of the malt to work with?—Anything between 10 and 100 grammes.

5869. (*Professor Thorpe.*) The amount, of course, to be taken must have some reference to the method which is used?—Quite so. That is the point I wish to accentuate. I want to point out that the method must be distinctly and definitely laid down. For example, if you take a thimble of glass and a cover glass, and introduce into the thimble copper from the Reinsch test, you will find it wants a large quantity of copper to get crystals, whereas the same amount of copper and the same amount of arsenic will give you, with the greatest ease, crystals quite distinct in a small tube. All you have to do is to diminish the size of the tube. In the one condition of things it is not obvious at all; in the other with the same quantity it is perfectly apparent.

5870. (*Dr. Whitelegge.*) What you said just now about standards referred more particularly to beer, did not it?—That was what I had in my mind at the time.

5871. Would you say a standard was necessary in the case of malt? The last witness proposed there should be a standard laid down by which the maltster should be guided, and which would enable him to give a certificate of freedom from arsenic?—I think that would be desirable. But if it were done in one case, I hardly think it would be necessary in the other.

5872. But you do not suggest at present what the standard should be in either case?—Certainly not. Without further investigation I do not think we are in a position to deal with the matter finally; to put it in a condition that would be acceptable to the whole country.

5873. Do you make malt and buy malt?—Yes.

5874. In the case of the malt you make, how long has it been the practice to use anthracite?—Anthracite alone has been used only since the middle of December last.

5875. Did you analyse the coal used?—Certainly not.

5876. You cannot give us any figures?—No.

5877. You select the coal, I understand?—We do select, putting it broadly; we get it from the South Wales Colliery, where it is known from time immemorial to give the cleanest flavour. I do not think it has any reference to any other form of selection. Anthracite selected for malting value.

5878. Have you any apparatus for pneumatic malting?—No; we are putting up one, but we have not one working.

5879. When that is in use, will the anthracite coal still be exclusively used?—In regard to coal, as far as I understand, it depends whether they are going to dry in the drums or in kilns.

5880. You cannot tell us what the precise form of the apparatus will be?—I cannot tell you at the present time.

5881. In the case of the malt that is bought, do you ask for certificates?—Since the beginning of December certainly, and we examine samples before we attempt to buy. Malt examined for arsenic before purchasing.

5882. But in addition to the analysis you make, you ask for a certificate?—Certainly.

5883. (*Sir William Hart-Dyke.*) Certificate of purity?—Freedom from arsenic. Form of guarantee given by maltster.

5884. (*Dr. Whitelegge.*) Entire freedom from arsenic?—They give it to you broadly; you will not get any one of them to give a certificate that it is absolutely free. But they give a certificate "practically free."

5885. Are those words used, "practically free," in the certificate?—I have not seen a certificate, but I understand that is the form of certificate that is used.

5886. (*Sir William Hart-Dyke.*) Will you put in the form of a certificate?—I will obtain one, and let you have it. I think it would be very much better to get this from a maltster, who may have it in a printed form in his hands.

5887. (*Professor Thorpe.*) I venture to think you are rather at cross-purposes in this sense. The maltster gives a certificate in good faith that a thing is free from arsenic?—Yes.

5888. What he really does is to give it to an analyst, who takes a determinate amount and tests it by a definite method, and finds no evidence of it and he gives a certificate on that finding?—That is quite true.

5889. (*Dr. Whitelegge.*) He gives a certificate of freedom from arsenic or practical freedom from arsenic, whatever it may be, and it is useful to us to see what it is that he represents. You will let us have a copy?—Certainly. But I think you ought to get it from a maltster.

5890. (*Dr. Whitelegge.*) Have you had any difficulty in obtaining certificates with the malt you receive?—Inasmuch as I do not buy the malt, from my personal knowledge I can make no definite statement on that matter.

5891. You are not aware of any?—I do not buy the malt myself. As far as I understand your question, a certificate is required; the maltsters have to certify, but the difficulty of getting a certificate of absolute purity from the maltster, I have been informed, is so great that it is almost impossible to get them from any maltsters in England. does not specify absolute freedom from arsenic.

5892. So that we must expect to find the certificate you are going to let us have will stop short of absolute purity. In your printed *précis* you mentioned that a number of samples of beer in stock were examined; can you say how far back that would carry you?—Some of these samples were the brews of January twelve months, and then they came down as far as the current brews.

5893. (*Mr. Cosmo Bonsor.*) I think we have had pretty nearly the whole of your experience as regards malt, but have you tested the other ingredients of brewing, preservatives, and so forth?—Certainly. Preservatives tested for arsenic.

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5894. They have all been tested for arsenic?—Most carefully.

5895. You mentioned hops; I presume the hops were bought before the scare was known, and you did not ask for a certificate?—Certainly not—not at that time. We do ask for a certificate that they are free or practically free from sulphur.

5896. That has been also since the scare?—No; we have been doing it for ten years. As far as we possibly can we buy no hops containing free sulphur.

5897. (*Sir William Church.*) Do you test for that chemically or judge by the nose?—We test for it chemically. I have not published the method, but we eliminate the crystals and practically re-crystallise the sulphur out of it, and examine it microscopically.

5898. I asked you, because we have had the question answered by others, who say they can always detect the sulphur in hops by smelling?—The sulphur they smell is not free sulphur. It is combined sulphur; the sulphur of the washes or the sulphur put on the kilns during drying.

No suggestion that flaked malts and grits contained arsenic.

5899. (*Mr. Cosmo Bonsor.*) We are all aware there are other substitutes for malts used besides sugar, like flaked malts and grits; is there any suggestion that there has been any arsenic in them?—I have never heard of it.

5900. Should you be satisfied if the same Government inquiry were to cover the question of a standard for these things as well as regards malt?—Certainly. What I have said applies to the whole of the ingredients used in the manufacture or to the product.

5901. In plain language, you think that there need be no practical traces of arsenic in beer, the word "practical" to be defined by a Government authority?—That is my meaning, but of course the great difficulty comes in on the question of "practical."

5902. But we get rid of that difficulty by throwing the responsibility on to an authority who can vary it from time to time as knowledge comes?—Quite so.

5903. (*Sir William Hart-Dyke.*) With regard to hops, of course the quantity of hops used is very small compared with malt in brewing?—Certainly.

5904. Could you off-hand give the Commission, taking an 18 gallon cask of beer, the amount of hops used?—There is no difficulty about that at all. Taking pale ale as an example; in 18gals. of it there is, broadly, the extract of 40lbs. malt, the amount of hops being 2¼lbs. in the same bulk.

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Quantity of hops used in beer.

5905. Therefore, although you indicate in your evidence the possibility of a small portion of arsenic being found in hops, yet the risk from it would be infinitesimal?—Absolutely so.

5906. And you would rather wish to confirm what has been upheld by other witnesses, that the danger of arsenical poisoning as regards hops is very remote now, if not impossible?—That is so.

5907. And the two chief points you really wish to indicate as regards malt are the very great care with regard to the material used for fuel, and the special care with regard to the cleansing of the malt afterwards?—That is so.

5908. And further, I think by the evidence you have given you do not think the question should rest altogether there, but some standard might be applied for the sake of future security?—That is my meaning.

Difficulty of brewers in absence of authoritative tests for arsenic.

5909. Both as regards the beer and as regards malt?—Yes and all other foods. It would be a most grievous thing to keep the brewers of the country in the condition in which they have been for the last six months. It becomes an impracticable condition of things; everything is examined, everything has to be determined, and then there is the unsecurity of the results which some ales may give; for instance, your chemist may find a 1-200th of a grain to a gallon, and another finds 1-50th. How can you explain that? These are questions that will continually crop up and keep the brewer and brewer's chemist in such a condition that life will be fairly intolerable to him.

5910. You think, therefore, that the process by which this standard should be arrived at should be determined after very careful inquiry?—That I am satisfied about. The broad lines of the investigation are very well established. They want to be carefully worked out and put into a concrete form, every definition well described, so that no man could make a mistake over a question.

(Sir William Hart-Dyke in the Chair.)

5911. (*Professor Thorpe.*) The Commission, I think, would like to know something more in detail as to the last matter in your *precis* to which you draw attention, namely, the question of the particular method which you would suggest as to how these standards or determinations of what I may call limiting values in the amount of arsenic in beer or in similar materials could be arrived at?—My ideas in these matters are these. The described knowledge of the method by which these minute quantities are determined so vary amongst themselves, that in the face of such a condition of things it seems to me absolutely necessary that this Commission or some authoritative part of it should see that the point is investigated, on some definite and distinct lines. As you know, you have taken up determinaton of one of the constituents of butter, and three or four men who had knowledge of the matter came to the conclusion how it was to be done, and when the product under consideration was to be considered right.

5912. You are alluding to an action which was taken in my capacity as head of the laboratory to agree with the analysts as to what particular factors should be taken to determine a particular point. Is that strictly analogous?—I think so.

5913. In that particular instance to which you make allusion we had to put into effect a clause in a particular Act, and it was necessary to devise certain experimental conditions to give effect to a statement in that Act. There is nothing here analogous to that?—I quite agree with that. The committee of investigation, or whatever it might be, could act in a similar way. I think it can be distinctly proved that from time immemorial beer must have contained a certain amount of arsenic, and if a man asks for beer and is supplied with an article containing this amount of arsenic, whether he knows it or not, it cannot be asserted that he did not get an article of the nature and quality demanded. That is how the matter already concerns an Act of Parliament.

5914. What is in your mind is this, that you assume that samples will be taken under the provisions of the Food and Drugs Act, and that the allegation will be made that inasmuch as it contained arsenic it was not of the nature, substance, and quality demanded?—Yes.

5915. And what you want is provision to be made where the line is to be drawn?—Yes. Go back upon the old samples of beer, establish the amount of arsenic they contain and determine the value of the evidence there is to show the extent, if any, of the injurious effects attributable to them. Working on these lines I maintain it is perfectly open to such a Commission to lay down standards that would be workable and available.

5916. Do you propose that this Commission should do this?—Or a Sub-Commission appointed by this Commission.

Definition of beer *qua* arsenic needed for purposes of F. and D. Acts.

5917. Your point being that this Commission should address itself to this particular point in a clause of the Act of 1875, namely, to define when the beer is not of the nature, substance, and quality demanded, *qua* the amount of arsenic which it contains?—I think that is broadly the question.

How the standards necessary for beer and food might be established.

5918. How would you suggest that should be done?—I have not thought the matter out, but it seems to me such standards should go to the Government as a recommendation from this Commission, or that Government should be recommended to appoint a Special Commission of investigation of experts upon this one question alone.

5919. The reference of this Commission is very wide—it includes not only beer, but any article of food?—I know that is so.

5920. That would affect, of course, a great many interests. If the Commission set itself to work to satisfy the terms of its reference with respect to what you say it would involve a great many interests?—Naturally.

5921. What would be the constitution of the Sub-Commission which would handle this question, having regard to the occurrence of arsenic in food generally?—I cannot say anything about the large amount of labour it

would necessitate, but when the general good has to be considered that labour must not be considered.

5922. Perhaps you would state to us in detail what kind of constitution this Sub-Commission should have?—I have nothing really in my head at the present time, but it seems to me that a Commission like the Pure Water Commission, of which you have a fair knowledge, would handle the matter with satisfaction.

5923. Should it be a Committee exclusively composed of chemical analysts?—I think broadly so, with a medical element.

5924. It should be a mixed Commission of chemists and medical men?—Yes. It is rather difficult to see where the medical men come in. If it was once granted there was a certain amount of arsenic permissible it would be for the chemist to say how much arsenic there is, and for the medical men to say whether it is injurious or not. But I say point blank, the medical men give us no evidence up to the present time that although beer must have contained arsenic from time immemorial they have been able to attribute any injurious effect from the arsenic in that beer.

5925. Your suggestion means that there should be a committee of analysts to prescribe methods for the detection and determination of the amount of arsenic in foods and in drinks, and that that commission should be associated with medical men to assist them in arriving at some defining limit as to arsenic which should be permissible?—That is not my proposition at all. My idea is that the first object would be to determine what was the nature and quality of the article under consideration from time immemorial, and if it were proved that upon the average beer, for example, did contain a certain small amount of arsenic, it should be the function of the sub-committee or sub-commission to define definitely how that quantity or proportion should be determined, and then, of course, it would be for the doctors to say, and for the Government to decide, whether it was permissible or not.

5926. But beer of the nature, substance and quality demanded would be a beer brewed from malt and hops, it may be, with or without glucose, but the malt might have been dried with arsenical coke?—Yes.

5927. That might be of the nature, substance, and quality hitherto demanded?—That is my contention; they would have to go back and determine what has been the condition of things.

5928. Is it your contention that that standard should be based on beer now discovered to have been brewed from malt containing arsenic derived from coke?—That would be one of my contentions.

5929. That we should be content with such and such an amount of arsenic?—No; that would come in a medical opinion. Observations would be made upon it to see how far that has been injurious, and how far it is likely to be injurious; there will come in the medical opinion.

5930. That is an unknown factor in our inquiry, as to how far injury to health has in times past been due to the consumption of arsenic?—I simply put it in this way, that as far as I have read in this evidence at the present time, until it was discovered some time ago that beer was brewed from arsenical glucose, we had no evidence that any material injury was done to health by the use of beer from malt and hops alone, or with the addition of the materials that we are allowed by the Act of 1880.

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5931. I think I understand what your contention is, and I express no opinion about that?—I know it is a very broad question and a very large question, and not having thought the matter out until you suggested it to me, I am not prepared to give that answer which I might if I had thought it out. But I do not think there should be any difficulty. Your contention is, that there is an Act of Parliament that helped you in the case of butter. There is an Act of Parliament in my mind to help you in this case too, and that if you were to satisfy yourself that this contamination has been present from time immemorial in this article of food, it would be for you to say within what limits it should be permissible now.

5932. (*Sir William Church.*) When you say from time immemorial, there would be no arsenic until coal was used for drying malt, and I presume that until comparatively speaking a short time ago the greater bulk of malt was dried with wood?—With charcoal.

5933. (*Mr. Cosmo Bonsor.*) The other Act of Parliament to which you allude, I suppose, is the Act of Parliament of 1888, which gives the Excise power to stop any deleterious matter going into the beer?—No, that is not what I have in my mind. I think Dr. Thorpe understands what I mean. He had under the Sale of Food and Drugs Act to establish a certain fact, whether the article possessed such properties as to enable it to be declared a genuine article or not. I say the same thing applies to beer. This beer has been sold as an article of food for centuries, we will say, and that it must have contained arsenic. Therefore it would be difficult to say——

5934. (*Professor Thorpe.*) Pardon me. It can only have contained with certainty arsenic since coal or gas coke have been used?—Coal has been used for a long time—two or three hundred years or more.

Powers of Inland Revenue in respect of deleterious articles in beer.

5935. (*Mr. Cosmo Bonsor.*) But you are aware of that particular clause in that Act which gives the Board of Inland Revenue absolute authority to stop deleterious articles?—That is so.

5936. I presume arsenic in large quantities is deleterious?—That is where the large quantities come in. There is no doubt the Inland Revenue have, under that portion of the Act, absolute authority to prevent the use of glucose containing what they may consider deleterious quantities of arsenic. I am not quite sure even now that if Professor Thorpe found one-thousandth of a grain to a lb. in the sugar that he would not have the power of stopping it.

5937. Or in malt?—In malt or in sugar, because it would come to the question of how far it is deleterious.

5938. (*Professor Thorpe.*) I have not that statutory power. What you really drive at is that we should, somehow or other, by machinery, get that statutory power?—That is so.

5939. Have you anything more to say on the broad question?—No.

(Sir William Church in the Chair.)

Sir Lauder Brunton, called; and Examined.

Sir L. Brunton.

5940. (*Sir William Church.*) I believe you are a Fellow of the Royal Society, and physician to St. Bartholomew's Hospital?—I am.

5941. And you have made a particular study of therapeutics?—I have.

5941[1]. You studied the recent epidemic, and were a member of the Expert Committee of the Manchester Brewers' Association?—Yes.

5942. You are prepared, I think, to give the Commissioners an account of the action of arsenic upon the human system as observed during the recent epidemic?—Yes. If I may be permitted to give a short account of the general action of arsenic upon the body, I think I may be able to classify the symptoms observed in the present epidemic of arsenical poisoning so as to render it easier both to remember them and to understand the varieties which have been described. Arsenic belongs to the same chemical group as nitrogen, which not only constitutes nearly four-fifths by volume of the atmosphere, but is an essential ingredient of all living tissues, and may be called the pivot on which all life turns. Other members of the group are phosphorous and antimony, both of which have an action very much like arsenic in many respects, and phosphorus, like nitrogen, is an important constituent of the healthy body. It is not certain whether arsenic acts by replacing nitrogen or phosphorous in the living tissues, and especially in protagon, which is one of the most important constituents of nerves, but it appears to have the power of altering the chemical changes or metabolism which occurs in them during life, and on which their function depend. In minute doses it appears to be beneficial, but in large doses it is poisonous, and will

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destroy both animal or plant life, so that in large quantities it will produce in man or animals irritation and inflammation of any part of the body on which it may be applied. This application may be made directly to a part, or the arsenic may reach it through the circulation. Thus, arsenic, when it is swallowed, reaches the stomach and intestines by direct application, and by irritating them produces vomiting and purging. In the form of dust, as from wall paper, or in making artificial flowers, it may enter the eyes, nose and air passages, and, thus, it may produce conjunctivitis, nasal and respiratory catarrh, and cough; or it may be applied directly to the skin and cause irritation and eruptions upon it. If much diluted it may produce little or no local irritation of the stomach, intestines or respiratory passages, but from these it may be absorbed by the blood, and carried by the blood to every part of the body. When absorbed from the stomach and intestines it is obliged to pass through the liver before it can enter the general circulation, and consequently the largest amount of arsenic is usually found in this organ after death from arsenical poisoning. Whilst circulating in the blood it may act on the heart, muscles and nerves. But it is not carried by the blood only to these organs, for through the circulation it goes a second time to the stomach, intestines, respiratory passages and mucous membranes of the eyes and skin. By these organs it is eliminated, and during the process of elimination it may again give rise to irritation in them just as it would do if directly applied. Moreover, John Hunter, Sir Everard Home and Sir Benjamin Brodie have shown that when arsenic is applied to a wound it produces more violent and more immediate inflammation of the stomach than when the poison is administered internally, and that this inflammation of the stomach precedes any appearance of inflammation in the wound (Phil. Trans. 1812, Pt. 1, pp. 209-210). Brodie concludes that "it may be inferred that arsenic, in whatever way it is administered, does not produce its effect even on the stomach until it is carried into the blood." This conclusion is perhaps too sweeping, and not strictly true for arsenic in large doses and in a concentrated form, but it is probably quite correct when the poison is taken in moderate or small doses, and in a diluted form, as in the beer at Manchester. Whilst circulating in the blood arsenic is carried to every organ and tissue of the body, and affects markedly the nervous system and muscles, the mucous membranes and skin. It begins to be eliminated by the kidneys within a few minutes of its absorption, and is also eliminated by the mucous membranes and skin. If only small doses are taken daily the whole of the poison may probably be daily eliminated, and it may be taken for months without any harm. But if the doses are larger, less is eliminated daily than is absorbed, and it becomes stored in the body and produces symptoms of poisoning. During the process of elimination it irritates all the mucous membranes and the skin, and produces corresponding symptoms. By irritating the mucous membrane of the stomach it causes loss of appetite, nausea, vomiting and epigastric pain. In the intestine it produces colicky pains and diarrhœa. By irritating the respiratory tract it gives rise to coryza, cough, hoarseness, huskiness of the voice, oppression of the chest, retrosternal pain and bronchitis, with occasional hæmoptysis. In the eyes it causes irritation, conjunctivitis and œdema of the eyelids. In the skin it produces all sorts of eruptions, nettlerash, redness, papules, pustules, vesicles and boils. Three of the most marked are pigmentation, herpes, and a condition to which the name of keratosis has been given in which the epidermis peels off the palms of the hands and soles of the feet in large flakes. Keratosis is probably due to the local action of arsenic upon the skin, for Ringer and Murrell found that in frogs poisoned by it the cuticle could be readily stripped from the body, and Nunn showed that this is due to softening of the protoplasm in the epidermis, so that it becomes almost completely detached from the dermis. The herpetic eruptions, as well as loss of hair, brittleness, or shedding of the nails, excessive sweating and subcutaneous œdema, however, are probably dependent rather upon the action of arsenic on the trophic or nutritive nerves of the skin to which reference will afterwards be made. During its circulation in the blood arsenic acts on the muscles of the limbs, on the muscular fibre of the heart, on the liver and other glandular organs, and especially upon the nerve trunks, although it acts, also, to a small extent on the spinal cord and brain. It thus tends to cause anæmia, as well as fatty degeneration of the muscles and of the heart, so that the limbs become feeble, and the heart so weak that death may occur from its failure. The liver also undergoes fatty change. The nervous system, and especially nerve trunks, are especially attacked by the poison. Nerve trunks usually contain fibres having three different functions, namely sensory, motor and trophic or nutrient, and all those functions are altered by the inflammation which arsenic produces in the nerve trunks. The alterations are of two kinds; first, the nerves are unable to do the things they ought to do; and, secondly, they do things they ought not to do. The sensory nerves instead of conveying definite impressions to the brain become dulled, so that the patient does not feel external objects with the same accuracy that he or she ought, and in consequence complains of numbness, and may be unable to distinguish where or what things are, and may thus, for example, be quite unable to sew, or even to write, and may drop things from the hand unwittingly, while the patient may feel as if his feet were walking on wool instead of on the floor. At the same time, the sensory nerves convey to the patient impressions for which there is no real objective ground. He may feel as if pins and needles were running into him, insects were running over him, or he may feel intense burning or pain of all sorts in various parts of the body, and both the skin and the muscles may be so abnormally tender that the slightest touch or pressure is not felt as touch or pressure, but causes the most intense suffering. On account of the weakness of the motor nerves the patient soon gets tired, and then certain muscles become so weak as to act only imperfectly, or may become completely paralysed, and not act at all. On this account the gait becomes feeble and staggering, the feet drop, the hands drop, the patient becomes unable to walk or stand, and may be even unable to feed himself, while on account of the diaphragm being weak or paralysed the respiration becomes feeble and imperfect. By stimulating the trophic or nutrient nerves, and perhaps by directly altering the tissue change of the parts themselves, arsenic may at first appear to increase nutrition, so that small quantities render animals or men taking it plumper and more active, their hair grows more thickly, and their skin appears clearer than before. But if this point be overpassed, the animals or men become thinner and wasted, the skin dry and hard, peeling off in scales, and often much pigmented. This pigmentation varies in appearance. It is sometimes slight but general, sometimes patchy, and sometimes so generally diffused and deep in colour as to make the patient appear to belong to a dark-skinned race. The peeling of the skin generally occurs in bran-like scales, but the epidermis may separate from the soles of the feet and palms of the hands in very large flakes. To this the name of "keratosis" is given. Local swellings of an œdematous or dropsical nature may occur in various parts of the body, and are particularly noticeable in the eyelids. The spinal cord may also undergo alteration, and some of the neuralgic pains, the loss or perversion of sensations of heat or cold, loss of reflexes and want of co-ordination in movement may be partly due to alteration in it, as well as to alteration in the nerve trunks. In some cases, although rarely, the brain has been found to be affected, and symptoms of melancholia or mania have occurred. The nervous ganglia of the heart may be weakened, and this, along with the feebleness of its muscular fibre, already mentioned as due to arsenic, may lead to syncope, or even to death. The nerves which regulate the contraction of blood vessels are said by Böhm to be paralysed by large doses of arsenic, so that the vessels dilate, especially those of the abdomen, and this, along with the weakness of the heart, explains the low tension of the pulse observed in severe cases during this epidemic. The blood vessels of the soles of the feet and of the palms of the hands become much dilated, so that the skin of these parts towards the outside becomes very red, and at the same time it becomes exquisitely tender and very painful. This condition is known under the name of erythromelagia.

Elimination of arsenic from the body and its results.

eratosis,

Herpes.

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Fatty change.

Neuritis.

Paralysis

Pigmentation.

Œdema

Erythromelagia.

5943. Do the symptoms vary with the amount of arsenic taken?—All the symptoms I have mentioned may occur in chronic arsenical poisoning, but they may not all appear in the same person or to the same extent, for their occurrence may depend upon the quantity of arsenic they have taken, upon the length of time its administration is continued, upon the form in which it is taken, and upon the personal peculiar idiosyncrasy of the person taking it. Small quantities of arsenic, such as the 50th to a 10th of a grain, may be taken by many people for months together with no apparent bad health, but, on the contrary, with better

Individual susceptibility to arsenic.

nutrition and increased strength. In these cases it is probable that the whole of the arsenic is eliminated daily as quickly as it is taken, and that there is no storage of it within the body; but if larger quantities are taken, so that the whole is not eliminated, it will gradually accumulate, and symptoms of poisoning begin to occur, which may become very severe or fatal. Yet, if the administration of the drug be stopped before a fatal issue is reached, the poison which has already been stored up in the body is gradually excreted, and the patient may recover even when apparently at death's door. But during the process of elimination symptoms of sub-acute poisoning may occur, and the arsenic which has been stored up for awhile in the body may, in passing out through the mucous membranes of the intestine and stomach, irritate them and produce vomiting and purging, as in some of Mr. Dixon Mann's cases three weeks after the arsenic had ceased to be taken.

5944. Are some persons so constituted as to bear larger doses of arsenic than others?—The effect of arsenic can be modified by the age, strength, and constitution of the patient taking it, women usually being able to take less than men, and children very much less than either. Susceptibility to arsenic varies very considerably, and while three minims of Fowler's solution, which is a 1 per cent. solution of arsenic, and is the preparation commonly given in medicine, will sometimes cause such symptoms of intestinal irritation as will necessitate its discontinuance, other patients will take 30 minims, or even more, three times a day without any discomfort whatever. The way in which it is given alters its action, so that if five minims of Fowler's solution were given on an empty stomach three times a day it would probably produce irritation of the stomach and intestines, whereas if given when the stomach was full it would be diluted by the food and be absorbed without producing any local irritation whatever. When much diluted in the form of beer, the local action of arsenic on the stomach and intestines at the time of taking it is probably very slight, and the gastro-intestinal irritation observed during this epidemic was comparatively trivial as compared with the other symptoms, and was probably due to irritation of the mucous membrane occurring during its elimination. During the circulation of arsenic in the blood, it is not improbable that its action may be determined to one part of the body or to another by other substances taken at the same time. A well-marked instance of this kind of action is known in the case of mercury. Alcohol is well known to have a strong affinity for the nervous structures in the body, whilst that of mercury is much less. But alcohol seems to direct mercury to the nervous system, and cause it to act upon them. An example of this is given by the fact that during the preparation of an alcoholic compound of mercury, called mercuric methide, two chemists who were subjected to the fumes were poisoned by the compound, and showed signs of nervous disease, one of them becoming maniacal and dying within three months, and the other becoming idiotic, and dying after about a year's confinement in a lunatic asylum. Osler has observed that mercury taken along with alcohol seems to have more tendency to produce peripheral neuritis than if taken alone, the alcohol seeming, as it were, to direct the arsenic to the nervous system. If the statements made by some of the patients who have suffered in the present epidemic of this arsenical poisoning as to quantity of beer they have taken are correct, the amount of arsenic consumed in some cases must have been so exceedingly small as to lead one to ask whether the neuritis can be due to arsenic alone, even though its action may have been directed to the nerves by alcohol or hops, or whether some other poison besides arsenic has not been present in the beer, or whether the arsenic is not present in such a combination as to have a much more deleterious action than that of pure arsenic itself. There are difficulties in accepting the statements of some of the patients as correct, for in the case of Alice Booker, which terminated fatally, and in which Dr. Stevenson separated a weighable quantity of arsenic from the viscera, the patient only admitted having taken less than one pint per diem. It is quite possible that arsenic may be present in beer, combined with either a hydrocarbon or with a proteid, for although it is said not to unite with albumen to form an albuminate, it has been found to enter into combination with casein. At present, however, this is only a hypothesis, and Professor Hewitt and I are at present engaged in investigating the subject. It is, however, a research full of difficulties, and if we succeed in obtaining definite results at all, it will probably not be until after the expiration of several months at the earliest.

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5945. Do you know of any other facts bearing on the hypothesis you have just mentioned?—Yes. In an epidemic of arsenical poisoning at Würzburg, where the arsenic was contained in bread, only one case of paralysis was observed in 373 cases of poisoning. This extraordinary want of action on the motor nerves when taken in bread as compared with its action when taken along with alcohol in beer or wine tends to substantiate my hypothesis.

Difference in symptoms between arsenic poisoning from beer and from bread, as in Würzburg.

5946. Have you any doubts as to the epidemic in Manchester being due to arsenical poisoning?—I have heard doubts expressed as to whether the epidemic in Manchester was due to arsenic at all, and I confess that when I first went I thought that possibly the symptoms might be caused by organic impurities in beer, such as some of the higher alcohols, *e.g.*, fusel oil, by albumoses, or by furfural. But an examination of the facts has convinced me that the epidemic was due entirely, or almost entirely, to arsenic. No doubt neuritis may be produced by toxines of an albuminous nature, such as occur in the body in diphtheria, in plague, and in beri beri, or are found outside the body in diseased grain, such as ergot and maize, producing ergotism and pellagra. But in the present epidemic the cases of illness were distinctly traced to beer. There was no diseased grain used in its production, no evidence of any infective disorder; in fact, there has been no evidence of the presence of anything excepting arsenic, and possibly selenium, that would produce the symptoms. These symptoms consisting in a combination of gastro-enteric irritation, peripheral neuritis, pigmentation, and eruptions of the skin, are almost characteristic of arsenical poisoning. They occurred in previous epidemics. For instance, in the one which occurred in Hyères, in which a number of persons were poisoned by arsenic in wine, the symptoms were almost identical with those of the present epidemic. In both these epidemics the symptoms may be conveniently classed in the manner adopted by MM. Vidal and Ollivier for those observed at Hyères into:—

Symptoms of Manchester cases like those in Hyères due to arsenic in wine.

(1.) Digestive.
(2.) Cutaneous.
(3.) Nervous.

In both epidemics the digestive symptoms were not nearly so prominent as would have been expected from the well-known irritant action on the digestive canal which arsenic produces in cases of acute poisoning, and in some cases symptoms of this sort were completely absent. They seem to have been rather more marked at Hyères than at Manchester, a circumstance which one would naturally expect both from the more irritating action of wine as compared with beer on the mucous membrane of the stomach and intestine, and from the larger proportion of arsenic in the wine (·08 gramme per litre). The digestive symptoms were alike in both epidemics, viz., loss of appetite, vomiting, abdominal pain, and diarrhœa. Retrosternal constriction or pain was noted in both, and I have mentioned it already along with cough, but at Hyères it was attributed to digestive derangement. In both epidemics the symptoms produced during absorption were slight in comparison with those which occurred during the circulation of the poison in the system and during its elimination.* The cutaneous symptoms which occurred were of the most varied kind in both epidemics. In Hyères the forms were so manifold as to exhaust dermatological nomenclature, and they were no less so in Manchester.† In both epidemics two of the most striking cutaneous symptoms were pigmentation of the surface generally, and separation of the epidermis from the feet and hands in such huge flakes that it seemed as if the whole skin of the soles and palms came off in one piece (keratosis). At Hyères coppery patches on the skin and an eruption the colour of burnt coffee were noticed, but the pigmentation does not appear so have been so dark or so extensive as in some of the cases at Manchester. In both epidemics the nervous

Great variety of skin affections.

* MM. Vidal and Ollivier say "Les ingestions repétées de doses dissemblables, mais relativement élevées, d'arsenic n'ont été suivies que d'accidents peu importants correspondant à la periode d'absorption; les plus sérieux se sont montres pendant la diffusion dans l'organisme se surtout l'élimination. Bull. de l'Acad. de Med., 1888, T. xx, p. 624.

† According to M.M. Vidal and Ollivier "Si l'on voulait donner un nom adapté exactement à la forme de toutes ces eruptions il faudrait épuiser la nomenclature dermatologique actuelle. Bull. de l'Acad. de Med., 1888, xx, p. 623.

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symptoms were the most important, and in both cases they were at first attributed to alcohol and not to arsenic.* In both epidemics, although numbness and loss of sensation were observed, they were not such prominent symptoms as pain and tenderness, weakness and paralysis. In both pain was a most marked feature, varying in intensity from slight "pins and needles" to most intense agony; and a very striking symptom was extreme tenderness to touch or pressure, so that the patients could not bear the pressure of the bedclothes on their limbs. Extreme tenderness of the calves and other muscles of the body on pinching, as well as the redness and exceeding painfulness of the soles of the feet and palms of the hands (erythromelalgia), which were so marked in the Manchester cases, are less prominently noticed in the accounts of the Hyères epidemic. Something of the same kind seems, however, to have been present for the patients are said to have complained of pain as if dogs were gnawing their calves and the soles of their feet. In both epidemics the muscular weakness or paralysis, the difficulty in walking, the peculiar gait, and sometimes the complete inability to stand, were all alike. Both resembled each other, also, in the affections of the respiratory system; indeed, with the slight difference indicated already, the symptoms in one epidemic might stand for those of the other. In both epidemics there can be little or no doubt that the symptoms were chiefly, if not entirely, due to arsenical poisoning, for (1) there was an absence of any other sufficient cause, (2) there was sufficient arsenic to cause symptoms of poisoning, (3) the symptoms corresponded with those which have been observed in cases of chronic poisoning by arsenic taken in other ways.

5947. Then you have no doubt in your mind that the recent epidemic was due to arsenical poisoning?—When I first went to Manchester to investigate the epidemic I started with the idea that the symptoms of poisoning were probably due not to the arsenic in beer, but to some other impurity, but I soon found that the arsenical origin of the epidemic could be proved beyond a doubt. The present epidemic is certainly due to contamination of beer through glucose and invert sugar made by one particular firm, who had been supplied with sulphuric acid containing a very large quantity of arsenic. The extraordinary number of cases of peripheral neuritis which have occurred in this epidemic, together with the fact that this disease has been specially observed and described by two Manchester men, Professors Ross and Dreschfeld, naturally raises the question whether the peripheral neuritis, a disease which is commonly attributed to alcohol, is not caused in most, if not in all, cases by arsenical poisoning, and whether poisoning by arsenic may not have been going on to a greater or less extent in Manchester for many years. A good deal may be said on both sides of this question. On the one hand, it cannot be denied that peripheral neuritis may be caused by toxines, for it is found in diphtheria, where no poison except that of diphtheria has gained access to the organism, and Sidney Martin has shown that the diphtheritic toxine, apart from the bacillus, will produce neuritis in animals. But, on the other hand, although it is commonly supposed that alcohol will cause the disease, it is by no means certain that ethylic alcohol will do so, and alcoholic neuritis in spirit drinkers may possibly be due to other substances than ethylic alcohol. A remarkable observation was made to me in a letter by Sir William Gairdner. About sixteen years ago he was examining in Manchester, and went through the wards of the late Dr. Ross. He saw there several cases of peripheral neuritis, and was much astonished because he could not recollect seeing more than two cases in Glasgow in all his life. He wondered if he could have overlooked the disease, but after consideration he came to the conclusion that it did not exist in Glasgow, notwithstanding the large quantity of whisky which was drunk there, and ought to have produced the disease if it were due to alcohol as usually supposed. The fact that arsenic has now been found both in hops and malt renders it not improbable that cases of peripheral neuritis in Manchester may for years past have been due to a certain amount of contamination of beer by arsenic through hops and malt, and although it is not yet certain, it seems probable that this contamination may have arisen from the use of coal or coke containing arsenic in the process of drying.

Peripheral neuritis before the epidemic may have been caused by arsenic.

5948. Have you anything to say with regard to the recent discovery of selenium in beer?—The recent and remarkable discovery of selenium in beer by Professor Tunnicliffe imports a new factor into the question, but further information is required before any conclusion can be arrived at as to whether this substance may be partly to blame for producing neuritis, and if so, to what extent.

More information needed as to selenium in beer.

5949. You wish to make some observations on objections which have been raised to the practice of using glucose in brewing?—The occurrence of this epidemic has caused an outcry against the practice of using glucose and invert sugar in brewing, and a demand that only barley and hops shall be employed. But I am informed that this would render it difficult to brew the light beers similar to the German lager or Pilsener beers which have come to be so extensively drunk in this country within the last thirty years. I regard the introduction of such light beers as a benefit to the public, for it supplies a drink which can, if pure, be taken without causing the heaviness, drowsiness, stupidity and headache which so commonly follow the consumption of heavy ales.

5950. And you wish to indicate that indirectly the recent epidemic may have given a useful lesson?—Although this epidemic has done much harm, has caused great pecuniary loss to the brewers, who were not to blame, and, still worse, has caused great pain, paralysis, and, in some cases, death to the unwitting consumers of the contaminated beer, it has not been without its advantages. For it has shown how a poisonous substance may find its way into a chemical, and, through it, not only into beer, but many other substances used as food. It has shown, also, how a poison like arsenic may find its way into food in such unexpected ways as through hops and malt, and thus enforces the necessity of guarding the consumer not by placing restrictions upon manufacture, but by demanding that the manufacturer shall in the future be held responsible for the purity of the articles he sells, and that all materials for beer or foodstuffs should be sold with a guarantee of purity which should be rigorously enforced.

Food manufacturer should be responsible for purity of his produce.

5951. With regard to what you say as to the action of arsenic when it is applied to wounds and external inflammations, is it not the case that arsenic coming into contact with the skin of those who are working in preparations of arsenic of itself produces very troublesome sores?—It does.

5952. Is that due to external application, and not to its having been absorbed?—No, to its local action. I have noted that it may be applied directly to the skin, and cause irritations and eruptions upon it.

5953. You say that the liver also undergoes fatty change. Of course in this epidemic there has been a mixture of alcoholic poisoning probably with arsenical poisoning?—I think in all the cases that I saw in Manchester the symptoms were mixed—partly alcoholic and partly arsenical.

Effect of arsenic on the liver.

5954. Would you mind telling the Commission a little more with regard to the changes that you think arsenic produces on the liver?—The liver cells undergo fatty degeneration. The substance of the cells themselves are more or less converted into fat. In cases of alcoholic degeneration you will very often find a greater enlargement of the liver than with arsenical poisoning, apparently more deposition of fat; not so much conversion of the protoplasm of the cells into fat, but an absolute deposition of fat from elsewhere.

5955. In very chronic cases of poisoning with either substance there are further alterations which you think differ in the two cases?—In the case of alcoholic poisoning one generally gets a large deposition of fibrous tissue, giving rise to hardening and afterwards to a contraction of the liver, the fat being absorbed. I do not know that this is observed to anything like the extent, or has indeed ever been observed to any extent, in cases of arsenical poisoning. Most of the observations on the action of arsenic on the liver have been made upon animals, and of course in them the poisoning is carried out quickly, and there is not the same time for observation that there is in cases of alcoholic degeneration of the liver in man.

5956. So that we really know very little with certainty with regard to the action of arsenic upon the liver when carried on for long periods of time?—Very little.

5957. Could you tell the Commission anything with regard to Dr. Dixon Mann's cases, where three weeks after the arsenic had ceased to be taken, irritation of the stomach and intestines took place? Do you know whether any examination of the urine was made at that

* "Jusqu'au 20 mars," dit le Dr. Dubrandy, "j'avais toujours supposé que les accidents pourraient bien être d'origine alcoolique et produits par l'usage d'alcools absorbés en nature ou sous forme de vins vines pris en excès." Bull. de l'Acad. de Med., xx, p. 620.

time, whether it was really certain that arsenic was passing out of the body at that time?—I regret I cannot state definitely. These cases were described by him at a meeting of the Royal Medico-Chirurgical Society. He made the statement very positively that there were cases of arsenical poisoning, but I cannot at this moment recollect whether, during the time when the symptoms were developed, arsenic was observed in the urine or not.

5958. Would that not be a proof that arsenic was really being eliminated at that time, whereas this is only an inference from the occurrence of the purging and vomiting? Some persons are so constituted as to bear larger doses of arsenic than others?—Yes.

5959. And the effect of arsenic, as you say, can be modified by the age, strength, and constitution of the patient taking it, women usually being able to take less than men, and children very much less than either—that is, when arsenic is given medicinally?—Yes, when one knows definitely that the patient is taking arsenic, and knows the exact amount that is given.

5960. Is it generally recognised, that women can take less than men, bulk for bulk of body?—I should not say bulk for bulk. This is only a general statement of men compared with women, and not men and women as compared by body weight.

5961. Or children?—Children I do not think stand it nearly as well. Some of them do, but children, as a rule, do not bear arsenic so well as grown-up people. The intestines seem to be more irritable, and the proportionate dose is very apt to cause pain and diarrhœa.

5962. Does the susceptibility of different children vary very greatly?—Enormously, I think.

5963. Is that the only reason that you can advance for women having apparently suffered more severely than men in this epidemic?—No, I think it is that the women have really taken more beer, and that possibly the women have been supplied always with the same kind of beer—that they have gone to a public-house near at hand, so that where they have taken arsenical beer they have taken it continuously. A man moves about and perhaps drinks arsenical beer at one public-house, non-arsenical at another, and so on. So that the two reasons, I think, are that the women have actually drunk more beer than the men, and that they have drunk regularly beer containing arsenic, whereas men who have drunk a good deal may have had a mixture of beers.

5964. Do you think that the greater physical labour of the men leads to more rapid elimination of the arsenic?—That is possible, but I do not know.

5965. Have you any information to give the Commission with regard to the work that you are carrying on with Professor Hewitt which you alluded to?—We find it an exceedingly difficult problem. We have tried to obtain from beer arsenical products, but they are so exceedingly difficult to obtain, and so exceedingly difficult to settle their constitution, that we are thinking of beginning really from the other end, and of trying to obtain arsenical substances which may be possibly present in beer. For example, we think of trying to obtain arsenical ureas in which the nitrogen of the ureas should be replaced by arsenic and several other compounds of that sort. If we succeed in those we may possibly go on to try and obtain arsenical albumoses. But the substances present in beer are certainly very complex, and we have not come to any definite conclusion as yet.

5966. Have you any evidence that arsenic is present in the beer in a complex organic condition?—There is no definite evidence yet. The reason for supposing that it may be so is this, that in the case of epidemics where the arsenic has been taken in alcoholic liquids there has been much more affection of the nerves. In one case, for example, where a large number of cases occurred from arsenic taken in bread, the nerves were not nearly so much affected.

5967. That possibly may be explained by the joint action of the two bodies together, without imagining that they form a new body?—That is quite possible. As I said, it is possibly determined by the action of the alcohol.

5968. Have you any doubts as to the epidemic in Manchester being due to arsenical poisoning?—None whatever.

5969. Recognising now that it was due to that at Manchester, would you mind stating whether you think there were any reasons why the doctors at first were slow in recognising it?—I believe that for a number of years cases of neuritis have occurred in Manchester.

5970. Would you anticipate that neuritis was the form of disease which would first attract attention in arsenical poisoning?—No. But the number of people suffering from alcoholic neuritis was supposed to be due to alcohol, and not to arsenic.

Epidemic at first wrongly attributed to alcohol.

5971. That you have mentioned. I am asking whether anything has occurred to you to explain the delay of the profession generally in recognising that this disease in Manchester was due to accidental arsenical poisoning, and not to alcoholic poisoning or any other poisoning. During the early part of the epidemic, the great absence of sickness and diarrhœa amongst the people who were taking arsenical beer was noteworthy. The first symptoms that attracted attention were not gastric, which is usually the case in arsenical poisoning?—There is that, and their being familiar with cases of neuritis due as they supposed to alcohol. They therefore classed these cases, which might have otherwise attracted attention, as being due to alcohol. If I might put it in other words, their familiarity with alcoholic neuritis misled them because they attributed the neuritis always to the alcohol and to nothing else.

Greater prevalence of alcoholic neuritis in Manchester before the epidemic.

5972. Do you think it is a fact that alcoholic neuritis has been much more prevalent in Manchester, Liverpool, and the neighbourhood than in London and district?—I think it must be so, because it was in Manchester that the disease attracted so much attention. It was there very clearly described by Ross and Dreschfield, whereas men in other parts of the country had not seen the cases or else had passed them over. Sir William Gairdner, of Glasgow, told me that he had been examining in the Victoria University, and was much struck with the fact that there was not only one but two or more cases of peripheral neuritis in Dr. Ross's wards. It struck him all the more because he had not seen such cases in Glasgow. On taxing his memory he could not remember more than two at the very outside in the whole of his life, and yet people in Glasgow drank enough whisky to give them alcoholic neuritis if the neuritis was due to alcohol pure and simple. Although he could not explain this prevalence of alcoholic neuritis in Manchester at the time, on learning that people had been drinking beer containing arsenic, he went over the facts, and came to the conclusion that the neuritis he had observed was probably not really alcoholic but arsenical.

5973. The profession generally in London were quite conversant with what they call alcoholic neuritis in London?—Yes, but not to the same extent.

probably due to arsenic.

5974. That leads you to think that it is possible that arsenical poisoning has been going on for some time?—Yes.

Glycerine in wine.

5975. With regard to Professor Gairdner's remark, is it not true that apparently different alcoholic drinks do produce different changes in the tissues of the body?—I think it is quite true. I once came across rather a curious observation in regard to different kinds of wine, which was made to me by the landlord of a hotel, and not by a medical man. The landlord of the hotel of Les Avants, above Montreux, told me that the people in their own valley who drank white wine all became affected with tremor, so that they were obliged to give up their occupation, whereas the people who drank red wine in the same localities did not suffer in the same way. The actual explanation of that I have not been able to find out, but it was suggested to me that the white wine was often more or less sweetened with glycerine, and that the glycerine might possibly contain arsenic, and that those people who drank white wine might be suffering from arsenical tremor brought on through taking white wine sweetened with glycerine.

5975. Is it not the case that whisky does not seem to produce the same sort of degeneration upon the internal organs that gin does?—That is quite true, I think. For example, in the liver there is one variety of diseased liver which is known under the name of "gin drinker's liver," and which appears to be more marked in the case of those who drink gin than in those who drink whisky.

5977. It is comparatively rarely found in Edinburgh and Glasgow, or Scotland generally?—Yes.

5976. So that the mere fact of alcoholic paralysis not being so prevalent in Scotland may depend upon some unknown cause, just in the same way as cirrhosis of the liver is not so common in Scotland from alcohol?—Yes.

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5979. Do you think there is any widespread feeling against the practice of using glucose in brewing?—I do not think so.

Pure glucose not injurious in beer.

5980. Is glucose likely to be injurious when used in beer?—No, certainly not. It seems to me that glucose is one of the things about which you can be absolutely certain that it contains no arsenic.

5981. Do you think there would be any difference when the glucose or invert sugar was added in the copper in making the wort, or if it was added afterwards to the finished beer? There is a process which they call priming in which glucose is used?—I suppose that if it was added to the beer before fermentation some of it might be taken up by the yeast and thus removed from the beer.

5982. I mean pure glucose?—No, I do not think so.

5983. You think that pure glucose, used in brewing, if it is fermented, is perfectly wholesome?—Perfectly.

5984. And you think that the resulting liquid is equally wholesome if it is added after the fermentation has been completed?—Perfectly so. Glucose is a perfectly innocuous substance and an excellent food. The results would be different as regards the liquids. As regards the health of the person, they are both perfectly innocuous.

5985. It has been given in evidence before us by one medical man that he thought the beers brewed with glucose were not so wholesome, and more often led to vomiting and stomach troubles than those which did not contain a large quantity of glucose?—I know of no facts which would lead one to believe that. I cannot deny it, because I have not the data.

5986. You know nothing which would lead you to think that the addition of this unfermented glucose to the finished beer would be likely to cause the beer to be unwholesome?—No, except that in very large quantities sugar of any kind disagrees with some people, whether in the form of glucose or saccharose.

A Government Board of reference should control purity of food.

5987. Have you thought out at all in what way guarantees of purity should be rigorously enforced by the manufacturers in buying materials?—I think that practically we want in this country something corresponding to the German Gesundheitsrath, a Board of Public Health, and that such a Board should have at least one representative of various sections. One would require at least one man thoroughly acquainted with public health, and the management of public health affairs. You would want a thoroughly trained chemist; you would certainly want a bacteriologist; you would want a man to investigate the action of any poisons that might happen to turn up, a pharmacologist, and you would also want a medical man—five different representatives, and probably you would want instead of one of each, several.

5988. Several members?—Yes, several members of each section.

5989. With what bodies would this board be in relation, and how would it work?—I have not thoroughly considered the relationships of it; I have only thought that it would have to take cognizance of questions brought before it by public analysts and medical officers of health.

5990. It would be a board of reference rather than a board of action?—Yes.

5991. (*Professor Thorpe.*) With what Government department would it have relations?—Unless the Local Government Board were reconstituted it would come into relationship with the Local Government Board.

5992. (*Mr. Cosmo Bonsor.*) Would it be appointed by the President of the Local Government Board and discharged by him?—It might be so.

5993. (*Professor Thorpe.*) Take any particular case, boracic acid, on which you gave us evidence before the Committee. After taking evidence, and making such inquiries, suppose that this board came to the conclusion that the use of that particular antiseptic was injurious, what would follow on that finding?—Then instructions should be given to the medical officers of health that all cases where boracic acid was found should be prosecuted.

5994. Under what Act?—I should think the Sale of Food and Drugs Act would cover that, would it not?

5995. Not unless somebody had declared it to be a noxious and deleterious thing, and not of the nature, substance, and quality demanded?—The question whether boracic acid was a noxious thing or not would be referred to this board.

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5996. If the board came to the conclusion it was, your idea is that they would recommend the Local Government Board to take action under the provisions of the Sale of Food and Drugs Act?—Yes. We must have some definite advising body to whom such questions could be referred.

Peripheral neuritis an aldehydes.

5997. You have just drawn our attention to the different mode of action of different forms of commercial alcohol. You instance, for example, the difference in the mode of action of gin and whisky. I believe you have given some attention to the action of the aldehydes. Is it possible that the action may be in some way connected with the presence or absence of bodies of this character?—That I cannot tell. I thought at first it might be. When I went to Manchester I saw so clearly that it was arsenical poisoning and not connected with the aldehydes. One reason why I believe that it is not connected with the aldehydes is that in the epidemic of Hyères the symptoms resembled exactly those of the epidemic in Manchester, and the ordinary light wine of the south of France contains very little aldehydes.

5998. You quickly satisfied yourself in the case of the beer that it was due to the arsenic, because arsenic was found in relatively large quantities, and the symptoms corresponded to those produced by arsenic; but nevertheless, is it not possible that the continued ingestion of small quantities of furfuraldehyde is capable of producing peripheral neuritis?—That I cannot tell, because these are just the questions that at present there is no possibility of settling. At present the only way to settle such a question would be either to make a prolonged series of experiments upon animals, which would very likely give unsatisfactory results, and the other would be to let a number of people go on taking a kind of spirit which we know to contain aldehyde. But one point about the aldehydes is that they are present in Scotch whisky, and in Glasgow, where the whisky was taken for a length of time and in considerable quantities, and where we may assume—although, perhaps, we have no definite evidence—that all that time the people were drinking whisky containing furfural—probably they were, and did not get peripheral neuritis.

5999. Furfural would be most largely found in the newest whisky?—Yes.

6000. And it became eliminated by age?—Yes.

6000*. To it is due the physiological effect between aged whisky and new whisky?—Yes. In Glasgow I fancy they drink a great deal of new whisky.

6001. Does Irish whisky contain more furfural than Scotch whisky?—I fancy it does, but I do not know. I believe in Ireland there used to be a great deal of Irish whisky which paid no duty, and there was no separation between the alcohol and the impurities. The whole thing was simply distilled over, and that must have contained a large quantity of furfural.

6002. In illicit-made whisky there must be a large preponderance of furfuraldehydes and other aldehydes; but the amount of illicit whisky is so small that its influence as regards neuritis would probably not be detectable?—I hope so.

6003. (*Dr. Whitelegge.*) I did not quite gather whether you had any reason to think that arsenic in beer was probably not in the form simply of arsenious oxide?—No, I cannot say definitely. It is a hypothesis that requires to be worked out. As I said before, the practical research necessary to answer this question is an exceedingly difficult one. It takes a lot of time, and you get a great many disappointments.

6004. Have attempts been made by yourself or other experimenters to separate out the arsenic in whatever form of combination it exists, by dialysis, or in other ways?—Not by dialysis. Dr. Hewitt is working at the thing just now, and I cannot give you the data he has. But it has been more by precipitation.

Advant of light be

6005. You referred to the difficulty that would arise in brewing light beers similar to German lager and Pilsener, if glucose were disallowed? Am I right in supposing that glucose is not used in brewing those beers in Bavaria and other parts of Germany?—I believe that is quite true. It comes to be really an economic question. I only speak from hearsay. I was told that our barley contains a much larger quantity of nitrogenous substances than the foreign. That if we use malt made from British barley, without the addition of glucose to

counterbalance the extra nitrogenous matter, we are bound to have a very heavy beer, such as was prevalent some thirty years ago. There are only two alternatives, we must either add glucose, or else we must go to Germany, or some place for the lighter barley to make malt with.

6006. So that the difference arises from the difference in the English and German barley?—That is so.

6007. I did not catch what you said was the difference between the malts?—The German barley contains a smaller quantity of nitrogenous matter. There is a larger proportion of starchy matter, and if we brew with English barley we get into the beer too large a proportion of nitrogenous matter, and to counterbalance this we must put in some extra saccharine, and if this is not done the other alternative is, we must go somewhere else and get a foreign barley from which to make malt, because the foreign barleys yield a smaller proportion of nitrogenous matter and a larger proportion of saccharine.

6008. You suggested the composition of a Board to pronounce an authoritative opinion on points in connection with the sale of Food and Drugs Act, not beer in particular, but foods in general?—Everything.

6009. Would you think of such a body as exercising any control over the processes of manufacture?—No, I think they had better not. It would be a great pity to interfere with the processes of manufacture.

6010. You suggested that the manufacturer should in future be held responsible for the purity of the article he sells. You would not think of that as a function of the body you propose?—No. The Medical Officers of Health would get specimens of various articles, or if the purchaser complained of some product being impure, it might well be submitted to such a Board, and their decision upon it would be final, instead of as at present simply involving a lawsuit.

6011. Their opinion as to the harmfulness or the reverse of a given constituent found by analysis?—Yes.

6012. You are not thinking of a Court of Appeal on the question of analyses *per se*?—No, although that might very well be combined with it.

6013. Do you think of the Board as having any executive officers, or as relying entirely for its information on the public analyst or Medical Officer of Health?—I have not worked it out in detail, and I do not think I can give any very definite opinion upon that. In my own mind I had simply thought of the medical officer of health, but in practice it might come to be advisable for the Board to have officers of its own. Instead of beginning on a large scale, and working the thing out completely, I thought of beginning on a small scale, and seeing how it would work practically.

6014. Has the Gesundheitsrath a staff of inspectors?—I am afraid I cannot tell you that just now. I regret I have not looked up that point.

TWELFTH DAY.

WESTMINSTER PALACE HOTEL.

Saturday, 27th April, 1901.

PRESENT:

The Right Hon. LORD KELVIN (*Chairman*)

The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Professor THORPE.
Dr. WHITELEGGE.
Mr. COSMO BONSOR.

Dr. BUCHANAN, *Secretary.*

Mr. RICHARD CHARLES GARTON, called; and Examined.

6015. (*Chairman.*) You are partner in the firm of Messrs. Garton, Hill and Co., Brewing Sugar Manufacturers, of Southampton Wharf, Battersea?—Yes.

6016. Is your produce solely used in brewing, or is it also sent out for use in various articles of confectionery?—Exclusively used in brewing.

6017. Not made for golden syrup?—No.

6018. You tell us that your firm was established in 1860; your father was the first to introduce invert sugar for use in brewing, and he worked out the process in conjunction with Dr. Letheby and Dr. Herapath?—Yes.

6019. Your firm manufactures a large percentage of the total brewing sugars made in this country?—Yes.

6020. What percentages?—Approximately 45 per cent. of that manufactured in this country.

6021. Shortly previous to the establishment of the factory by your father for the manufacture of invert sugar, had glucose been manufactured?—Yes, it had; not on a very large scale.

6022. For what purposes?—For brewing purposes.

6023. Not very much before your father took it up?—Only two or three years before.

6024. What do you mean exactly by "invert," which appears to be used in different senses?—I mean the product of the action of acid upon the cane sugar employed; the sugar is given a left-handed rotation to polarised light.

6025. Does any right-hand polarisation of the crystallisable sugar remain, or is it completely changed?—It completely turns over to the left.

6026. And the strength of the invert polarisation, is it equal to the strength of the direct polarisation of the cane sugar before the use of the acid?—The polarisation of the pure cane sugar would be upon a scale, as I understand it, plus 56; but when it is turned to the left it would give a minus 12 or 13.

6027. So that the invert rotation is much less than the original rotation in the opposite direction?—Yes; but may I be allowed to ask my head chemist, Dr. Thorne, who is here, if I am correct in the figure? I find that the change should be from the ratio plus 36 to minus 12½.

6028. Some ten years afterwards there was added to your manufacture of invert the manufacture of glucose for brewing?—Yes.

6029. You tell us that at a later stage your father became associated with Mr. Cornelius O'Sullivan, one of the pioneers of the practical work of the transformation of starch into sugars?—Yes.

6030. Had he patented processes for doing that?—He had.

6031. Patented details for the mode of application of the acid and the mode of their removal?—Yes.

6032. There was a special product, dextrin maltose, the use of which arose from his work in conjunction with dextrin maltose.

Mr. R. C. Garton.

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your father. How is that distinct from glucose?—It is a transformation product between starch and glucose.

6033. It is a carbo-hydrate substance with properties intermediate between starch and glucose?—Yes.

6034. Glucose, invert and dextrin maltose are the only brewing sugars manufactured by your firm. They are all produced by the action of sulphuric acid either on cane sugar or starch?—Yes.

6035. Then various substances may be used for giving the starch?—Almost any starch-producing substance might be used for the manufacture of glucose.

Maize, sago, and tapioca flours made into glucose.

6036. Potato?—Potato might, but in our own case we confine ourselves to three products only, namely, prepared cornflour, sago flour, and tapioca flour.

6037. (*Sir William Hart-Dyke.*) Including maize?—Maize cornflour, but not raw maize. We do not use raw maize.

6038. (*Sir William Church.*) Nor rice?—Not in our own case. It is used in the manufacture of glucose, but not in our own specific case.

6039. (*Chairman.*) One of the cheapest forms of starch I suppose, is that derived from potato?—Not at the present day. It is not used in the manufacture of glucose in England at the present day. It is relatively dear as compared with other starches.

Rice and raw maize may be used.

6040. (*Professor Thorpe.*) I think it would conduce to clearness if you told the Commission, once and for all, what are the variety of starches used in the manufacture of glucose by all manufacturers, and what you yourselves specifically use?—I have given those which we specifically use. The other forms of starch would be rice and maize. Beyond that I do not think any other form is used.

6041. (*Chairman.*) Would you prefer tapioca to either rice or maize?—We ourselves do.

6042. Why?—There are certain oils and fats which are eliminated from rice and maize, which we consider to be detrimental in the manufacture of the brewing sugar.

6043. It would introduce an objectionable element, a disagreeable flavour?—Yes; it is a very disagreeable flavour at times.

6044. Would it be unwholesome in the beer?—I do not think the resulting product would be unwholesome, because of the subsequent process to remove anything of that character. But the starch of maize and tapioca flour and sago flour contains less nitrogenous matter, and is more easily worked than the other starches, hence we employ them.

6045. How is the sulphuric acid removed when it has done its work?—It is removed by the neutralisation of an alkali.

6046. What base do you use?—Chalk.

6047. No other?—We finish with a small percentage of lime.

6048. That has practically the same effect, lime and chalk?—Yes. No sulphuric acid is left in the solution in consequence.

6049. Do you find that the process of precipitation can be so complete as to leave no discoverable sulphuric acid?—I do consider so, and that is absolutely controlled by our laboratory department.

Amount of acid used in manufacture of invert.

6050. With respect to the manufacture of invert, do you use a definite proportion of acid?—The acids vary according to the class of sugar employed. We can use from so little as $\frac{3}{4}$ per cent. up to $2\frac{1}{4}$ per cent. as the maximum. I have taken out an average which we consider to be used, and that is $1\frac{3}{4}$ per cent. of sulphuric acid.

6051. How is the percentage reckoned, by weight of sulphuric acid to weight of starch, or sugar as the case might be?—Yes.

6052. (*Professor Thorpe.*) Is that real sulphuric acid?—That is of the 70 per cent.

6053. (*Chairman.*) One and three-quarters of sulphuric acid of 70 per cent. strength to 100 by weight of sugar?—That is so.

6054. (*Professor Thorpe.*) One hundred by weight of raw sugar, which is not pure sugar?—Yes. It would contain some invert sugar, and some moisture, and a little ash, and some alkaline salts.

6055. What would be the average of real sugar in what you are using?—About 90 or 92 per cent.

6056. (*Chairman.*) Ninety per cent. of crystallisable sugar?—No, of total sugar.

6057. That includes crystallizable sugar and uncrystallizable, including molasses?—Yes.

6058. There would be a considerable proportion of crystallizable sugar, and a considerable proportion of grape sugar?—Not a considerable proportion of the latter, not exceeding 8 or 9 per cent.

6059. With regard to the manufacture of glucose?—The percentage of acids will vary to a greater degree, almost, than in the process of making invert sugar. It would go from $4\frac{1}{4}$ per cent. in the case of American cornflour, which I described just now, up to 8 per cent. for some of the tapioca flour. It varies from $4\frac{1}{4}$ to 8 per cent., but I see that the average taken from our books is $5\frac{1}{2}$ per cent.

6060. (*Professor Thorpe.*) Of the 70 per cent. acid?—Yes.

6061. (*Chairman.*) How do you explain that more acid is wanted for one of the substances and less for another?—Because there is contained in these starches a large percentage of fibrous matter to which the acid goes instead of carrying on its direct conversion.

6062. Is that fibrous matter nitrogenous fibrine?—Yes.

6063. Do you use pressure in the manufacture of glucose?—That is so.

6064. Without the pressure you would need a still larger quantity of acid?—Yes, a larger quantity of acid would be employed without the use of pressure.

6065. (*Sir William Church.*) You speak of prepared cornflour; is that other than ground?—It is a precipitated starch after being washed and dried.

6066. (*Professor Thorpe.*) I think perhaps it would conduce to clearness if we had it upon the notes why treatment by sulphuric acid is required in these things as a process to begin with. Take the case of cane sugar. Cane sugar is a sugar fermentable by the action of yeast. When you add yeast to cane sugar, would you tell the Commission exactly what happens?—The first action would be that the yeast would act upon the cane sugar and invert it, but the process is an exceedingly slow one, and a very difficult one to carry out because of the manner in which it weakens the yeast plant. The object of inverting sugar by acid is to bring it readily into that state. In brewing when you add your inverted cane sugar the yeast is immediately able to go about its work, and is not weakened or deteriorated by having to do inversion first.

6067. When you act directly on cane sugar by means of yeast it requires a considerable amount of time before the true alcoholic fermentation is started?—That is so, and there is considerable danger that the alcoholic fermentation might not catch on in time to prevent the other bodies being formed.

6068. What you do by this hydrolizing or inverting by means of sulphuric acid is that you quicken the action you would otherwise have to do with the yeast?—Putting it in my own words, we assist the yeast to take on the vinous fermentation at once.

6069. You use the word "carbo-hydrate"; would you kindly explain what you mean by the word carbo-hydrate?—Perhaps I might ask Dr. Thorne to deal with this. It is more of a chemical term.

(*Dr. Thorne*) (Chemist to Messrs. Garton, Hill, and Co.) The carbo-hydrates are those series of compounds in which the composition of the substance is in the proportion of the carbon and water.

6070. All sugars are carbo-hydrates?

(*Dr. Thorne.*) Yes.

6071. But all carbo-hydrates are not sugars?

(*Dr. Thorne.*) No; carbo-hydrates would include all the starches.

6072. The word carbo-hydrate is a generic term including starches, sugars, and all substances in which the ratio of the carbon to the water is as you have stated. (*To the Witness.*) Some of these carbo-hydrates are fermentable and some are not?—That is so. Some of the sugars in those carbo-hydrates are fermentable and some are not.

6073. In the action of sulphuric acid upon the materials that you employ for the manufacture of glucose, the various starches with associated cellulose or similar matter, cellulose itself being a carbo-hydrate, does that cellulose itself contribute in any way to the formation of sugars?—Yes, it does. The cellulose is

converted into a form of sugar by the action of the acid.

6074. A fermentable form of sugar?—No.

6075. Then you really get more sugar in your glucose than corresponds to the amount of starch present with which you started?—That is if you have a lot of cellulose.

6076. In maize, where you would have a large amount of associated cellulose, do you get more glucose than corresponds to the amount of starch present?—I am not able to answer the question with maize because I have not worked upon it.

6077. Take the case of second grade tapioca and sago, where the mixed foreign matter other than starch is considerable?—It is minute.

6078. But you would have a certain amount of sugar other than from the pure starch?—It would be a very small percentage indeed.

6079. What do you mean by a very small percentage?—At the most it would be half per cent.

(*Dr. Thorne.*) Practically none of the cellulose is converted in the ordinary way of working; at most 1 or two per cent. of the cellulose present is actually converted.

6080. What do you mean by the ordinary way of working?

(*Dr. Thorne.*) The commercial way of working.

6081. But of course it is theoretically convertible?

(*Dr. Thorne.*) But it requires longer treatment and higher pressure.

(*Witness.*) In the face of that subject we are quite aware of the fact that these non-fermentable bodies could be formed if the starch was left too long in contact with the acid, and that is one of the things we have to guard against to prevent these bodies being formed by the destruction of the sugar which would be formed by the conversion by the remaining acid.

6082. (*Chairman.*) The acid you reckon at 70 per cent. with a specific gravity of 1·6. Do you dilute it before applying it to the starch?—Yes, it is diluted to a specific gravity of 1200.

6083. You spoke of pressure being used; what pressure do you go to?—30lbs. pressure. The vessels are made of gunmetal.

6084. And the liquor raised to boiling point at that pressure?—The action of raising the pressure brings it up; the vessel contains steam coils.

6085. What temperature is the liquor raised to in the vessel?—275° Fahrenheit.

6086. Does so high a temperature tend to alter the fermentability of the product?—We use our acid accordingly, and the time of the operation is a big factor in that connection. As a result of the conversion I think I may say that glucose in the ordinary form contains very little matter which has been transformed from sugar into a non-fermentable carbo-hydrate.

6087. Do you use pressure in the manufacture of invert as well as of glucose?—We never put cane sugar or sugar used in the manufacture of invert into a pressure vessel.

6088. If you were to apply to cane sugar the same pressure and temperature as in the case of glucose, would not that convert some of the sugar without acid?—We should caramelise the sugar.

6089. But as a fact it would be inverted?—Yes; but there would be also destruction.

6090. Would not that be fermentable?—No.

6091. Have you studied the optic property of caramel?—I have not, personally.

6092. It is inverted, is it not?

(*Dr. Thorne.*) Up to a certain extent; but the action is carried much further, it does not stop at invert sugar. When you get caramelisation taking place you get a large number of other carbo-hydrates, some of which are fermentable and some are not, and the caramel is not one product, but a mixture of decomposition products.

6093. (*Professor Thorpe.*) The process of caramelisation is attended with the abstraction of water?—Yes.

6094. (*Dr. Whitelegge.*) You told us that you manufactured glucose for brewers only: that meant brewers are your only customers?—They are.

6095. There is a considerable amount of glucose used in other manufactures than brewing, is there not?—There is.

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6096. That comes from the other manufacturers in England, and from foreign sources?—I think no other manufacturer in England sells other than for brewing purposes.

English glucose makers supply brewers principally.

6097. Can you say why—is the substance required different?—I cannot explain why because I could manufacture it myself for confectionery purposes, but we do not.

6098. What you would manufacture for confectionery purposes would be different in some respects from the article you make now?—The article used for confectionery purposes is that which I have described here as dextrin maltose, that is the composition of the article which is now used in the country for confectionery purposes.

6099. Do you make dextrin maltose?—Yes, for brewers, but not for confectionery.

6100. The dextrin maltose required for confectionery is different from the brewing dextrin maltose?—No.

6101. Is the dextrin maltose you manufacture suitable for confectionery?—Yes, it could be used, so far as dextrin maltose is suitable for confectioners.

6102. It is a mere accident that all you make goes to brewers?—Clearly; we could manufacture it for the confectionery market if it were deemed necessary.

6103. But I understand you to mean there is more than that, that the article you manufacture is suitable for confectioners if confectioners come to you to buy it?—Yes; so far as it is suitable for confectionery purposes; it is almost the identical substance; it is an intermission product after the conversion of starch by acid.

6104. Confectioners use other forms of artificial sugar, do not they, besides this?—I am not quite sure on the point.

6105. Do you supply cider makers or mineral water makers?—None.

6106. Can you tell us whether they use a sugar similar to what you prepare?—I do not think they do.

6107. Potato starch is used to make glucose abroad I understand you to say?—Yes.

Potato starch expensive.

6108. Not in England?—On account of its price only.

6109. Would the product be different at all in appearance or properties?—No, I do not think it would be. There is a distinctive property in glucose manufactured from potato starch, and that is that it has rather a bitter flavour.

6110. (*Chairman.*) Do you sell dextrin maltose as a separate product different from the brewing sugars?—Yes, by name of dextrin maltose. The invert cane sugar is sold under the name of laevo saccharum. The glucose is sold by us as dextro saccharum as denoting the two forms of sugar.

6111. What kind of sulphuric acid do you use, brimstone acid is it?—We originally used brimstone acid made from Sicilian brimstone.

Uses de-arsenicated pyrites acid.

6112. Did you give up the use of brimstone acid?—Yes, some years ago; the object was this, that the people from whom we bought our brimstone acid represented to us that by the process of purifying sulphuric acid we could get it as pure and as free from arsenic as the brimstone acid, and we satisfied ourselves upon that point, and after considerable research by our head chemist, at that time Mr. Heron, we adopted the use of the de-arsenicated pyrites-made acid.

6113. Arsenic was the special substance to be removed by purification?—Yes, we have been well aware of the presence of arsenic in acid ever since we have been in business.

6114. In the purification of pyrites acid is there anything but arsenic to be taken out of it?—There is iron and lead and the nitrous compounds.

6115. Does lead get into the pyrites acid?—Yes.

6116. Iron comes from where?—The iron would be in the pyrites.

6117. (*Professor Thorpe.*) The iron would be everywhere, in the coke and the towers?—Yes; I am only able to describe the particular points that we wished to avoid in our acid. I am not conversant with the actual manufacture of the acid.

6118. (*Chairman.*) Iron is one of the substances to be got rid of. How does it get into the acid?

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(*Dr. Thorne.*) I think it would come mainly from the coke in the Glover towers, and so on, that the acid ran over; not in the fumes, but only after the sulphur had been turned into liquid acid by the steam and moisture.

6119. (*Chairman.*) For the last twenty years you have always obtained your sulphuric acid from one source?—(*Witness.*) Yes; Messrs. F. W. Berk and Co. We have always dealt with them.

6120. Do they supply brimstone acid, or have they given up the making of it?—They have given up the manufacture of brimstone acid.

6121. (*Mr. Cosmo Bonsor.*) Has the price varied much for your acid?—The price has never varied at all. We have never discussed the price with them. We pay them a good price, and we have never gone into that question since.

Supply in special tank.

6122. (*Chairman.*) You take care that you get the acid not contaminated on the way to your works?—We are very cautious in regard to that, because we will only allow it to be supplied in one barge kept for us alone. It is not supplied in carboys. It is supplied in a tank barge.

6123. A tank of what material?—A lead tank.

6124. (*Sir William Hart-Dyke.*) Belonging to the vendor?—Yes.

6125. (*Chairman.*) A small quantity of lead may be taken up from the tank?—Not at the gravity at which we receive it.

6126. Do you receive it at the gravity of 1·6?—Yes; our own chemist takes charge of the acid as soon as it arrives at the works. No portion of the cargo is allowed to be discharged until our own head chemist has certified he is satisfied.

6127. (*Dr. Whitelegge.*) How long has that system been in force?—It may be 15 years; I cannot be quite sure.

No written contract with sulphuric acid maker.

6128. (*Chairman.*) Have you a written contract with Messrs. Berk?—No; we have never had a written contract with them. Everything is settled verbally. It is an old, long-standing arrangement which is continually renewed and discussed from time to time as we see them.

6129. There is no chance of their forgetting that there must not be arsenic in it?—We have their definite assurance that they examine every load before it leaves their place.

6130. (*Sir William Church.*) Messrs. Berk and Co.'s works are on the river, are they not?—Yes, at Bow.

6131. This arrangement could not probably hold good in another factory?—No. Other manufacturers do receive it in carboys, but ours is a very special way of receiving it, and makes it exceedingly easy to detect whether the acid is right or not.

6132. (*Sir William Hart-Dyke.*) And you can test a large quantity at once?—Yes; a large bulk.

6133. (*Chairman.*) You have perfect confidence in Messrs. Berk and Co., but you think it right to keep a check of the supply?—That is in accordance with our method of working; we check everything we take into the works. I do not mean any particular reference to arsenic, but everything is taken into the laboratory as it comes into the works in the ordinary way of business.

6134. You require colourless acid?—We have always colourless acid.

6135. Do you have any B.O.V.?—No; this acid is the colour of water. I have brought a sample, if you would like to see it. (*Sample exhibited.*)

6136. Do you know if brown oil of vitriol is used by any glucose manufacturers?—No, it is not.

6137. You consider the colourlessness of the liquid important as security against accidents?—Yes.

At a constant price.

6138. Do you get this at a constant price?—The price has never varied. I think acid can be bought cheaper than we buy it, but we have been satisfied to pay this price, feeling that we were in good hands, and that it would be unwise to discuss any question of economy.

6139. What is the price?—42s. a ton.

6140. For delivery in large lots?—We receive it in tank barges holding about 30 tons.

6141. You have invoices in support of this statement?—Certainly.

6142. (*Professor Thorpe.*) If Messrs. Bostocks were paying 47s. 6d. for the same character of vitriol, they were also paying a very good price too?—That included the carriage of carboys from Leeds to Liverpool. The carriage I expect would be a substantial item. Our carriage is a very minimum sum, because it is simply a tank journey from wharf to wharf.

6143. (*Mr. Cosmo Bonsor.*) Who does the tank-barge belong to?—Messrs. Berk.

6144. Does the price charged by Messrs. Berk vary with the market?—No; the price has been very nearly constant. I think perhaps in that we might have opened up a question, but we have always considered it was best to leave the price as it stood.

6145. Carriage to a distance would involve its being put into carboys?—It would.

6146. Would that be a source of danger?—I think it might be some source of danger that carboys might be mixed.

6147. But not with proper precaution?—No, none whatever.

6148. It would add largely to the cost?—Very largely indeed.

6149. (*Professor Thorpe.*) You are aware there are other methods of transmitting oil of vitriol than in carboys, even long distances?—No; I have not gone into that.

6150. You can send it in large cast-iron cylinders It is sent by railway constantly?—Naturally it could be done, in the same way as we have ours in a tank. It is merely a tank on wheels.

6151. (*Chairman.*) Have you ever examined the sugar with a view to detecting impurities, if there are any?—Not before this occurrence of the outbreak in Manchester.

6152. But in this outbreak?—We have analysed a large number of samples.

Glucose ly tested arsenic.

6152*. Have you found any arsenic in any of them?—It is extraordinary, seeing how very largely diffused arsenic is that the samples should be so free. I should not like to say that we have not found any arsenic, because the test is so extraordinary that you can find the minutest possible trace. I have here tubes, if the Commission would like to see them, of various quantities of arsenic that we have detected both in our acid and in other materials, but it is of such an infinitesimal and minute character that it almost might be called negligible. (*The tubes were submitted to the Commission.*)

only an infinitesimal quantity found.

6153. Is this from the sugars or some of the ingredients?—That is from the glucose, a glucose which we have made and tested by the Marsh test. The tube will show you how exceedingly free the sample was from arsenic under the severe test.

6154. Have you tested some of the raw materials?—Yes; but we find no arsenic in those. This is another tube, a glucose, which was made in the very early part of November, and represents a sample which was out at the time of the outbreak in the trade. There you see an infinitesimal spot. We have tried large numbers, and we find no trace, but I bring this one forward as showing what could be found. I think that contains about 1,000th part of a grain.

6155. In what quantity of glucose?—In a pound of glucose.

6156. That is a specimen, manufactured on the 10th of November, 1900?—Yes. In connection with that it would be interesting to see the standards. (*The standards were shown to the Commission.*)

6157. How do you account for the minute quantity of arsenic, in that specimen?—It might come from so many trivial causes. It might come from a tank, it might come from a little new charcoal over which it was put. Of course, we should never have found that amount under the old method of testing. That is the result of a test extending over nearly half an hour in the Marsh test. At 10 minutes that did not show any reaction at all for arsenic. I brought it up to show to the Commission how very minute it was, and the very small quantity that could be found. Here is a sample of the pyrites acid. (*Sample put in.*)

Brimstone acid not necessarily free from arsenic.

6158. This is the 23/3/1901, that is the 23rd March?—Yes. Here is a sample of the brimstone acid. (*Sample shown.*)

6159. This is the 26th April?—Yes. That was a sample of brimstone acid we had from the people who manufacture our pyrites acid. We have been going into the question of brimstone acid with them. They do

not make it, but we have been discussing with them as to whether we should buy brimstone acid in the future, and that is a sample we had to see how it looked.

6160. Of Sicilian brimstone acid?—Yes.

(*Dr. Thorne.*) That was not their manufacture, it is only a sample they obtained for us, not their own make.

(*Witness.*) But they are putting themselves into a position to make brimstone acid.

6161. (*Chairman.*) They got this from a brimstone acid manufacturer?—Yes.

6162. (*Professor Thorpe.*) Was that sold to you as free from arsenic?—That is not sold to us, it is only a sample sent to us to examine.

6163. But not put forward as free from arsenic?—I anticipate by its being sent in that form that it was. Here is a sample of another delivery of our acid. That is a pyrites acid.

6164. But there is something here?—Yes, that is the result where 20 grammes of the acid has been taken and kept in the Marsh test for half an hour, and that is the only result we could get.

6165. What do you consider the colour here proves?—It may be a trace.

6166. Might it be something else?—It might be anything. It is so infinitesimal that it is impossible to say. (*The standards were explained by Dr. Thorne to the Commission.*)

6167. (*Professor Thorpe.*) On the test which you have shown us, it would be obviously a greater security to insist upon de-arsenication in the acid, whatever it be, than to take it on the assumption that it was pure because it was made from Sicilian sulphur?—That would not do at all. The proper course would be to have a guarantee that the acid was de-arsenicated, apart from what it was made from. It would be a sense of false security to think that because you bought sulphur-made acid you would therefore have arsenic-free acid. With a guarantee of de-arsenicated acid you would be perfectly safe.

6168. (*Chairman.*) Do you know the process that Berk and Co. follow in making the acid? Is it the same as other pyrites acid makers?—Yes, they purify the acid for our purpose by a special process.

(*Dr. Thorne.*) By the sulphuretted hydrogen process.

6169. (*Chairman.*) Do you know how much difference that makes in the cost?—I think it is absolutely nominal.

6170. Do they sell acid not so purified to those who do not demand purity?—Yes. This is a sample of their brown oil of vitriol. (*Sample shown.*) It has not been purified. We asked them for this sample, which we thought might be interesting. It is not de-arsenicated.

6171. The price of this is not greatly less than the price of purified acid?—The difference is very nominal indeed.

6172. Do you know what the price of this is in the market?—I cannot give it to you definitely.

6173. (*Sir William Church.*) Have you had your acid tested for anything else besides arsenic?—Yes, from time to time.

6174. Has any special investigation of it been made for selenium?—Yes, our chemist has tested it for selenium.

6175. Has any trace of selenium been found?—Not in the pyrites acid.

6176. In the brimstone acid?—I think he has come to the conclusion that infinitesimal traces have been discovered.

(*Dr. Thorne.*) Yes. I have not come across a brimstone acid absolutely free from selenium, but I have not detected it in purified de-arsenicated pyrites acid. The process of purification takes out the selenium at the same time it takes out the arsenic.

(*Sir William Church.*) As far as any danger from selenium comes, there appears to be less in pyrites than in brimstone acid.

(*Dr. Thorne.*) I should say emphatically less.

6177. (*Mr. Cosmo Bonsor.*) The test for selenium is a very easy one, is it not?

(*Dr. Thorne.*) In large quantities, not in a very fine degree.

6178. (*Mr. Cosmo Bonsor.*) Anything that would be likely to be injurious to health would show itself very quickly?

(*Dr. Thorne.*) You can test easily to one part in 200,000. I say that because the arsenic test goes to one part in seven millions.

6179. (*Chairman.*) Would selenium show in the colour of the deposits we have in some of those tubes?

(*Dr. Thorne.*) Yes, but precautions have been taken in all those tests to remove the selenium in the process.

6180. Have you found selenium can be removed?

(*Dr. Thorne.*) It can be removed.

6181. You found there was selenium, which had to be removed?

(*Dr. Thorne.*) In brimstone acid I found selenium present. In pyrites acid I found no selenium present.

6182. (*Professor Thorpe.*) What you mean is that you so arranged your method of testing for arsenic that it would have eliminated any selenium which had been there?—(*Dr. Thorne.*) Yes. In those tubes it is arsenic, and there is not a chance of there being selenium. Selenium has been tested for separately, but not in that test.

Guarantee of purity of sulphuric acid or of manufactured article advisable.

6183. (*Chairman.*) (*To the Witness.*) Would it make any difference to you if there was a statutory guarantee of purity imposed?—The purity of the article we manufacture?

6184. Either of the article you manufacture or of the sulphuric acid that you admit?—It would not make the slightest difference, because we have always acted on that necessary guarantee to the public.

6185. You have gone on without a written guarantee, but by care on your own part and the part of the makers you find it satisfactory?—Absolutely satisfactory.

6186. Then it would not disturb you if there was a satisfactory guarantee of purity to be given by the acid makers?—It would not make the slightest difference to us in our manufacture, or any other way. We should be quite prepared to carry out any recommendation that the Commission might think fit to make.

Form of guarantee now issued with these products.

6187. Since the outbreak your firm have, in fact, adopted a form of guarantee for purity?—Yes. Immediately upon the outbreak we issued a guarantee, the form of which I have brought, and which is now in use.

6188. "We certify that the delivery to which the enclosed invoice relates is perfectly free from arsenic or other deleterious ingredients"?—That is the notice.

6189. (*Professor Thorpe.*) Who signs that guarantee?—One of the partners, every day.

6190. Does the chemist take part in the guarantee?—We receive his report before the guarantees are signed. He sends down his report to the partners on his samples, and we sign the guarantees then and there.

6191. Would there be any difficulty in making him jointly responsible for the guarantee?—Not the slightest difficulty in the world. He is practically now responsible, because we should not sign the guarantee without we had his authority to do it.

6192. But it would be desirable for statutory purposes that the name of the tester should go on the guarantee form?—That would not make the slightest difference to us; it could be very readily carried out.

6193. (*Dr. Whitelegge.*) Messrs. Berk and Co. are chemical manufacturers in general?—Yes.

6194. They make other things than sulphuric acid?—Not at these works.

6195. Do they make sulphuric acid for other purposes?—Yes, for manure purposes.

6196. And largely for those other purposes?—I am not able to say the extent of their manufacture. Their chief works, I think, for other chemical manufactures are at Swansea.

6197. But at the same works at which the sulphuric acid for your purposes are made, other sulphuric acid is made?—I believe it is.

6198. (*Chairman.*) You have made no change in your mode of action in respect of the supply of acid since this scare?—We have made no change in our methods at all. It was considered the proper course to pursue to go on just as we have been working.

Greater stringency in testing acid for arsenic recently.

6199. (*Dr. Whitelegge.*) Is there not rather a difference implied in your statement, that since the outbreak every material has been specifically tested for arsenic?—That is the only difference. The method has always been that a sample of the acid is taken directly the barge arrives. It is placed in the laboratory. That

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has been always the case. Now the only alteration is that we test each of those samples specifically for arsenic.

6200. That was not done before the outbreak?—Not every sample, but they were constantly being tested.

6201. Constantly being tested for arsenic?—Yes. In fact, it had been tested at quite a recent period before the scare. That was not done because we feared that the manufacturer was selling us an inferior article, but merely in our common way of business as a check.

6202. (*Professor Thorpe.*) Of course, this certificate that you give necessarily has reference to a particular method of testing?—Yes.

6203. And also to a particular amount of material which is used in the testing?—Yes.

Official standard for arsenic should be prescribed.

6204. Therefore it only indicates a particular standard of delicacy?—As applied to ourselves, yes. In that respect it would be most desirable that some common form of working should be adopted.

6205. What would you suggest as to how that common form of certificate should be arrived at so that all certificates might have equal value? Have you any suggestions to offer to the Commission as to how that could be attained?—Seeing that analytical chemists from all parts are constantly testing these samples, to my mind the best way would be to arrive at a common understanding by some conference.

6206. A conference arranged between whom?—Between those chemists and the officials.

6207. What officials?—The Government officials.

6208. (*Mr. Cosmo Bonsor.*) You would be quite satisfied if a Government Department was the reference?—Absolutely satisfied.

6209. (*Professor Thorpe.*) Are you speaking of brewers' materials or of things in general which may contain arsenic?—I am speaking of brewing materials.

might be done by Inland Revenue in the case of brewing materials.

6210. Would it satisfy you, for example, as a manufacturer of brewing sugars, if the Excise authorities were to take charge of a small departmental committee to fix the methods and generally prescribe the form of certificate under which all manufacturers of brewing sugar should work?—I think it would be most admirable. It would get rid of a great deal of trouble and the harassing that is now going on. In fact, I consider that it is absolutely necessary that some common form of guarantee should be arrived at.

6211. I may point out to you, of course, that the matter is rather far-reaching, because it does not merely concern the Excise authorities immediately, but it concerns, of course, public analysts who are not under the Excise remotely?—Yes.

with aid of Committee of chemists.

6212. Therefore you must have a rather wider organisation to take the whole thing into consideration?—That is why I made the proposition that the general body of chemists should be consulted as to the method to be adopted.

6213. That is rather a large order, is it not?—I think you could get representatives from the chemical societies.

6214. You mean that you would like to see a committee formed in which all the interests, say the Excise authorities, yourselves as manufacturers?—I think you might eliminate us from the conference.

6215. Would not the maltsters, for example, be concerned?—I think not. I think they would be perfectly satisfied if a common form was adopted.

6216. Then your idea is that a committee of chemists and persons concerned with the testing of brewing materials and also of the testing of finished beer as the public takes it, should draw up regulations with a view to determining methods for standards of purity?—I do think so.

6217. Supposing a committee had come to some arrangement defining the methods, and, therefore, conceting the degree of delicacy, what could they do further; to whom would they report; what further action is contemplated?—I do not quite understand.

6218. This Commission, for example, might appoint a small sub-committee or recommend the formation of a small sub-committee to take up that particular aspect of the question. They might make certain findings. What would be the subsequent action? How would they become operative?—You mean to say how would they be received.

6219. Who would deal with them?—Which department of the Government?

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6220. Yes?—I suppose the laboratories are not to be thought of. I do not know that I can make a suggestion.

6221. (*Mr. Cosmo Bonsor.*) You are aware of the two Acts of Parliament, the Sale of Food and Drugs Act, which looks after the adulteration of food generally, and also the regulations as regards the prevention of deleterious articles entering into beer which is looked after by the Excise. Either of these departments would do, would not they?—Yes, either would do, but I am quite unable to say which would be the better.

6222. (*Chairman.*) You have no experience of their action; you have not been attacked for adulterations nor for deleterious impurities by persons acting under instructions of either department of the Government?—No.

6223. You have no experience of such action, and cannot offer us any advice?—No, I cannot.

6224. But you are willing to accept anything that is proposed?—Yes.

6225. (*Dr. Whitelegge.*) Would you be equally content with administration in that sense by any local authority?—Do you suggest a County Council authority?

6226. Yes, by the county authorities or other local bodies?—I should prefer the other method.

6227. (*Chairman.*) Have you ever used any other than the Marsh test for arsenic?—No, we have always used the Marsh test.

6228. Have you ever used Bloxham's electrolytic test?—No.

6229. I do not know whether you or your chemist have thought of the electrolytic method?—(*Dr. Thorne.*) I have been intending to experiment with the electrolytic method, but really, my time has been so much taken up with this matter, and I have been so satisfied with the character of the result of the Marsh test and the delicacy and absolute certainty of the Marsh test, that for the present I have stuck to the Marsh test. I think that the Bloxham test might possibly be a very satisfactory one, but I do not think it can exceed the satisfactory character of the Marsh test.

6230. (*Chairman.*) Might Bloxham's method possibly give more definite quantitative results?

(*Dr. Thorne.*) I do not think so.

6231. (*Sir William Church.*) Your firm seems always from the commencement to have from time to time tested your sulphuric acid for arsenic?—Yes.

Duty of sugar manufacturer to check purity of his acid.

6232. As a practical manufacturer of what is really a foodstuff do you not think it is the duty of every manufacturer of foodstuffs similar to this, to take the same precaution, and from time to time test for themselves the purity of any substance like sulphuric acid which everybody knew might be contaminated?—I think as a check upon his business he ought to do so, but the great responsibility would lie with the manufacturer who makes the acid for him in the common understanding that they work together.

6233. You would say without doubt that where there is no specific contract that de-arsenicated acid is used it is the duty of the manufacturer of invert or glucose to see that the acid he uses is pure?—Yes, by a check.

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6252. With regard to your own trade. I do not want to ask you anything inquisitorial, but generally speaking, as regards your own trade, have you found any alteration in it since this scare occurred?—No diminution.

6253. You referred to the use of these materials, glucose and invert sugar, as being used for brewers for improvement of quality, and you make some comparison between their use and that of malt later on, where you state that there were certain difficulties with regard to brewing with malt which are got over by this quicker process. With regard to malt: is it not a fact that in the English barley growing districts in bad seasons, when the barley grown is not of very good quality, sugar has been very largely used?—Yes; that is to enable the brewer to use that quality of barley.

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6254. That is to say to supply the saccharine matter which is absent in the barley?—Yes.

6255. In a season where a very good sample of barley is grown in this country there is naturally more of the barley used for malting purposes minus this addition which is otherwise necessary?—The sugar is not so necessary when a good quality of barley can be produced.

6256. You are aware that in debates in the House of Commons on this question of malting and the use of substitutes, it has been said by leading brewers in the House of Commons that if they were forced to use nothing but barley they would have to go to the foreigner so as to get the very best article when a good sample is not grown in this country?—Yes. I confirm that absolutely as a brewer. I consider that unless a true sense of the position is quickly ascertained, one of the most serious blows to the farmer is now about to take place. This recent agitation on behalf of the pure beer movement, resuscitated because of the arsenic scare, has carried the whole history of the use of these brewing materials into a new phase, and if this Pure Beer Bill were passed, I have no hesitation whatever in saying that the British barley grower is practically doomed. I will give you a specific instance which will emphasise all I have said. In anticipation of what is going to happen in connection with this Bill, a brewing friend of mine in the North, who has never used foreign barley at all, has this week purchased 10,000 quarters, which he is going to use in the place of English barley. That has only to be accentuated throughout the country, and I think the last stage of the British farmer will be very much worse than the first.

6257. Are you an agriculturist yourself?—In a small way.

6258. I suppose so long as your trade lives and thrives you would be rather in favour of the use of malt, generally speaking, for beer?—I am taking it from a scientific point of view, and also from the point of view that I am a brewer in a very considerable way.

Saving of storage.

6259. You urge that one of the difficulties with regard to the malt brewing is the prolonged storage that is necessary?—True.

6260. Surely you are aware that beer brewed from malt and hops is a very popular beverage in this country?—I am not inclined to accept that theory. I think a good deal of political agitation has been raised on the subject, but I have my doubts as to whether it is the popular beverage.

6261. You have your doubts?—Very strongly.

6262. You would not urge that the necessity of storage was a great difficulty in the use of malt and hops?—I think you cannot produce even with lengthened storage the quality of beer which the ordinary public require to-day; malt and hops alone would not produce it; you would have to re-educate the consumer to malt and hop beer.

6263. You think that when once the consumer is initiated in what you consider the merits of beer brewed under the system you advocate, he would not go back again to the other?—It will take a very long time to get him back to the old malt and hops.

6264. You are aware that evidence has again and again been given before this Commission that by common care in malting, beer brewed from malt can be made absolutely secure?—That is the fault I have to find with the manufacturer who brought about this trouble—that even with common care his sugar need not have contained any arsenic.

6265. In either case, as regards the consumer, you wish to urge upon the Commission that it is really a question of common care whether brewing from malt or brewing from glucose?—Yes; the whole question of arsenic in these materials is quite new to us all.

No economy in use of invert sugar.

6266. (*Chairman.*) Is there not an economy in the use of invert, to save the cost of malt?—There is no economy in the use of invert sugar.

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has been always the case. Now the only alteration is that we test each of those samples specifically for arsenic.

6200. That was not done before the outbreak?—Not every sample, but they were constantly being tested.

6201. Constantly being tested for arsenic?—Yes. In fact, it had been tested at quite a recent period before the scare. That was not done because we feared that the manufacturer was selling us an inferior article, but merely in our common way of business as a check.

6202. (*Professor Thorpe.*) Of course, this certificate that you give necessarily has reference to a particular method of testing?—Yes.

6203. And also to a particular amount of material which is used in the testing?—Yes.

Official standard for arsenic should be prescribed.

6204. Therefore it only indicates a particular standard of delicacy?—As applied to ourselves, yes. In that respect it would be most desirable that some common form of working should be adopted.

6205. What would you suggest as to how that common form of certificate should be arrived at so that all certificates might have equal value? Have you any suggestions to offer to the Commission as to how that could be attained?—Seeing that analytical chemists from all parts are constantly testing these samples, to my mind the best way would be to arrive at a common understanding by some conference.

6206. A conference arranged between whom?—Between those chemists and the officials

6207. What officials?—The Government officials.

6208. (*Mr. Cosmo Bonsor.*) You would be quite satisfied if a Government Department was the reference?—Absolutely satisfied.

6209. (*Professor Thorpe.*) Are you speaking of brewers' materials or of things in general which may contain arsenic?—I am speaking of brewing materials.

might be done by Inland Revenue in the case of brewing materials.

6210. Would it satisfy you, for example, as a manufacturer of brewing sugars, if the Excise authorities were to take charge of a small departmental committee to fix the methods and generally prescribe the form of certificate under which all manufacturers of brewing sugar should work?—I think it would be most admirable. It would get rid of a great deal of trouble and the harassing that is now going on. In fact, I consider that it is absolutely necessary that some common form of guarantee should be arrived at.

6211. I may point out to you, of course, that the matter is rather far-reaching, because it does not merely concern the Excise authorities immediately, but it concerns, of course, public analysts who are not under the Excise remotely?—Yes.

with aid of Committee of chemists.

6212. Therefore you must have a rather wider organisation to take the whole thing into consideration?—That is why I made the proposition that the general body of chemists should be consulted as to the method to be adopted.

6213. That is rather a large order, is it not?—I think you could get representatives from the chemical societies

6214. You mean that you would like to see a committee formed in which all the interests, say the Excise authorities, yourselves as manufacturers?—I think you might eliminate us from the conference.

6215. Would not the maltsters, for example, be concerned?—I think not. I think they would be perfectly satisfied if a common form was adopted.

6216. Then your idea is that a committee of chemists and persons concerned with the testing of brewing materials and also of the testing of finished beer as the public takes it, should draw up regulations with a view to determining methods for standards of purity?—I do think so.

6217. Supposing a committee had come to some arrangement defining the methods, and, therefore, conferring the degree of delicacy, what could they do further; to whom would they report; what further action is contemplated?—I do not quite understand.

6218. This Commission, for example, might appoint a small sub-committee or recommend the formation of a small sub-committee to take up that particular aspect of the question. They might make certain findings. What would be the subsequent action? How would they become operative?—You mean to say how would they be received.

6219. Who would deal with them?—Which department of the Government?

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6220. Yes?—I suppose the laboratories are not to be thought of. I do not know that I can make a suggestion.

6221. (*Mr. Cosmo Bonsor.*) You are aware of the two Acts of Parliament, the Sale of Food and Drugs Act, which looks after the adulteration of food generally, and also the regulations as regards the prevention of deleterious articles entering into beer which is looked after by the Excise. Either of these departments would do, would not they?—Yes, either would do, but I am quite unable to say which would be the better.

6222. (*Chairman.*) You have no experience of their action; you have not been attacked for adulterations nor for deleterious impurities by persons acting under instructions of either department of the Government?—No.

6223. You have no experience of such action, and cannot offer us any advice?—No, I cannot.

6224. But you are willing to accept anything that is proposed?—Yes.

6225. (*Dr. Whitelegge.*) Would you be equally content with administration in that sense by any local authority?—Do you suggest a County Council authority?

6226. Yes, by the county authorities or other local bodies?—I should prefer the other method.

6227. (*Chairman.*) Have you ever used any other than the Marsh test for arsenic?—No, we have always used the Marsh test.

6228. Have you ever used Bloxham's electrolytic test?—No.

6229. I do not know whether you or your chemist have thought of the electrolytic method?—(*Dr. Thorne.*) I have been intending to experiment with the electrolytic method, but really, my time has been so much taken up with this matter, and I have been so satisfied with the character of the result of the Marsh test and the delicacy and absolute certainty of the Marsh test, that for the present I have stuck to the Marsh test. I think that the Bloxham test might possibly be a very satisfactory one, but I do not think it can exceed the satisfactory character of the Marsh test.

6230. (*Chairman.*) Might Bloxham's method possibly give more definite quantitative results?

(*Dr. Thorne.*) I do not think so.

6231. (*Sir William Church.*) Your firm seems always from the commencement to have from time to time tested your sulphuric acid for arsenic?—Yes.

Duty of sugar manufacturer to check purity of his acid.

6232. As a practical manufacturer of what is really a foodstuff do you not think it is the duty of every manufacturer of foodstuffs similar to this, to take the same precaution, and from time to time test for themselves the purity of any substance like sulphuric acid which everybody knew might be contaminated?—I think as a check upon his business he ought to do so, but the great responsibility would lie with the manufacturer who makes the acid for him in the common understanding that they work together.

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Saving of storage.

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No economy in use of invert sugar.

6266. (*Chairman.*) Is there not an economy in the use of invert, to save the cost of malt?—There is no economy in the use of invert sugar.

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6267. Why should it be used?—Because it produces a better result than all malt alone.

6268. So that you consider that the buyer would be inclined rather to take beer not certified to be malt and hops alone?—I think he would if he were left alone.

6269. (*Sir William Church.*) To put it another way—you say that both, looked at from the scientific aspect and also from the practical aspect as a brewer, that a better quality of beer can be produced by a certain quantity of invert sugar and glucose being used than without it?—Emphatically.

6270. Do you think that if a large percentage of glucose or invert sugar is added it might impart any unwholesome property to the beer?—No, it would not. I say this distinctly, that if you use too large a percentage you do not get a beer, you get that which is more inclined to be a wine.

6271. Do you think it makes any difference in the wholesomeness of the finished beer whether you use a large proportion of glucose or invert sugar before the fermentation of the beer, or whether you add it afterwards?—I do not think it makes any difference, because the sugar in itself is perfectly pure and wholesome; in one case it is split up into the carbonic acid gas and the alcohol, and in the other case it may be that some of the sugar remains in the beer unsplit up, which the fermentation continues to split up as it goes along.

6272. May we take it as your opinion that it is not for lessening the cost of materials that brewing sugars are employed?—It is not.

6273. (*Sir William Hart-Dyke.*) I suppose that what I may call the more modern process of brewing without storage, although the materials are more expensive, yet the beer is brewed in one month and drunk the next month. Given the demand for it, the brewers would not lose much as against the old storage method?—There is an economy, I grant, in the fact that you can get your beer into condition earlier, but there is no economy in the first cost of the material.

6274. (*Mr. Cosmo Bonsor.*) You mentioned a friend of yours in the North who bought 10,000 quarters of foreign barley. Was that since the Budget statement of the Chancellor of the Exchequer?—It was this week.

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6275. Possibly it may have something to do with using the foreign malt to replace glucose and invert sugar?—I have it from his own mouth that it was in anticipation of the fact that he will probably be called upon to produce a so-called pure beer by English barley malt, and he will have to buy foreign to supplant it.

6276. It was not the tax on the glucose or the sugar that was frightening him?—No; because he promised me he will continue to use my sugar notwithstanding the price.

Proportion of invert sugar used at his Brewery.

6277. (*Dr. Whitelegge.*) In your own brewery you use glucose and invert sugar?—No; we do not use glucose.

6278. Only invert sugar?—Yes.

6279. What is the maximum proportion?—20 per cent.

6280. (*Chairman.*) Going back to the barley—Why is it not possible to fulfil the condition of nothing but malt and hops without introducing foreign barley?—The English barleys are so unripe and contain so much nitrogenous and albuminous matter that it is perfectly impossible to get the clarifying effect upon them without you have what is generally called more sun in your mash-tun.

6281. So that brewers are obliged to get barley from more sunny climes than our own to make a good result if it is to be an all-malt beer?—That is so.

6282. (*Mr. Cosmo Bonsor.*) As a brewer, there is no difficulty in getting beer free from arsenic?—No. Practically free, commercially free.

6283. You see no difficulty, either as a manufacturer of this glucose or as a brewer?—None whatever.

6284. Leaving the test of what is commercially free to a Government authority?—Distinctly.

6285. (*Chairman.*) In case the Commission would like to see the process of your manufacture, would it be convenient to you to allow us to come?—Distinctly, at any time.

Dr. Nathan Raw, Medical Superintendent of the Mill Road Infirmary, Liverpool, called; and Examined.

Dr. N. Raw.

6286. (*Chairman.*) You are Medical Superintendent of the Mill Road Infirmary, Liverpool?—Yes.

6287. And consulting physician to the West Derby Union Workhouse?—Yes.

Epidemic in Liverpool less extensive than in Manchester.

6288. The recent epidemic of arsenical poisoning does not seem to have been so extensive in Liverpool as in Manchester?—No.

6289. You have put in a statement as to the number of patients admitted?—During the last three years, out of 12,823 patients admitted into Mill Road Infirmary under my care, there have been 225 cases of peripheral neuritis, of which number 153 have presented symptoms which might be attributed to arsenic. Of these 226 cases of peripheral neuritis 51 died, the apparent cause of death being general asthenia, with cardiac failure in most of the cases. As bearing on the question as to when the arsenical contamination of beer commenced, the statistics of this infirmary are of great value, and recent disclosures have proved that my suggestion that the poisoning commenced in May last is probably correct.

Statistics of peripheral neuritis at Mill Road Infirmary

The following table shows the number of cases of neuritis admitted into Mill Road Infirmary during the last three and a-half years:—

	1898.	1899.	1900.	1901 to April 22.
January	3	8	—	13
February	1	1	5	—
March	1	8	1	2
April	—	1	2	1
May	3	4	7	—
June	2	3	11	—
July	4	—	12	—
August	1	3	17	—
September	3	2	25	—
October	2	2	22	—
November	3	1	16	—
December	3	1	25	—
Total	26	34	143	23

Dr. N. Raw.

6290. Your table shows that during the years 1898 to 1899 the number of cases of neuritis average thirty for the year, but a sudden increase was first noticed in the beginning of June?—Yes.

6291. Which steadily increased to the end of 1900?—Yes. In fact, the cases continued to appear until almost the middle of January; then they suddenly ceased, and I have not had a case for over nine weeks.

Towards end of epidemic symptoms of acute arsenical poisoning.

6292. Reviewing the epidemic as a whole, and after careful observation, what have you concluded?—Reviewing the epidemic as a whole, and after very careful observation, I have noticed the cases to be divided into two important classes: (1) The acute.—Of these I have only seen 17 cases. They occurred late in the epidemic, about the beginning of December, and presented a totally different set of symptoms from those of the more advanced or chronic cases. These cases had the appearance of having been suddenly and acutely poisoned with a large dose of arsenic. The symptoms, although acute for a few days, soon passed off, and the patients made a rapid recovery, and in all cases were discharged recovered. (2) The Chronic Cases.—These formed by far the greatest number, and on admission presented the usual symptoms of peripheral neuritis, and had the appearance of some slow and chronic form of poisoning attributed at that time to alcohol. Although I have been in the habit of seeing cases of alcoholic neuritis for the last fifteen years, I had not noticed any difference in the character of the symptoms in patients admitted into this infirmary until the beginning of August, when a few of the patients showed well-marked general pigmentation of the skin, which for want of a better diagnosis, was attributed to Addison's Disease. During the next three months six cases were diagnosed as Addison's Disease, although it was felt at the time that the cases were not typical of that affection. Of these six cases three died, and on post *mortem* examination no evidences whatever were found to confirm the diagnosis of Addison's Disease; on the contrary, the cause of death seemed to be alcoholic neuritis. It was not until the paper of Dr. Reynolds appeared at the end of November that my attention was directed to arsenic, and then, of course, the epidemic was explained, and steps at once taken to prevent its

Earlier cases resembled alcoholic neuritis.

Pigmentation simulating Addison disease.

spread. With regard to the cause of alcoholic neuritis I am convinced, from a very careful observation of a very large number of cases, that beer and porter are the general drinks consumed, by far the greater number being due to beer alone; but I have certainly seen cases of undoubted alcoholic neuritis in which the patients have only taken brandy or whisky. With regard to this point my experience whilst in charge of a large Scotch hospital for four years is of interest, as during the whole of that time I only saw four cases of peripheral alcoholic neuritis, and it is well known that the popular drink in Scotland is whisky. I believe also that the serious lesions are caused by the continual drinking of moderate quantities every day for prolonged periods, rather than to sudden outbursts where large quantities are taken and rapidly excreted.

6293. (*Chairman.*) What are the serious lesions to which you refer?—The paralytic symptoms.

6294. It is probable now that these lesions were due to arsenic?—The recent cases undoubtedly must have been accelerated by arsenic. The great majority of cases of ordinary alcoholic neuritis occur amongst women of the poorer classes, and in Liverpool it is the custom for these women to congregate in each other's houses and send for cheap beer during the whole of the day. By consuming it off the premises they get what is called "the long pull," which means that they get a good deal more beer than they ask for. I mention this because when a patient says she has taken a pint of beer a day, one can safely assume double that amount. I understand that in Liverpool this practice of giving the "long pull" has now been abolished.

6295. (*Sir William Church.*) Did the acute cases show traces of any pigmentation?—Not at all. In none of the acute cases was any pigmentation seen.

6296. With regard to the "long pull," do you mean that when they send to the public-houses for a pint they get two?—They get between 1½ and 2 pints, if the beer is consumed off the premises. But if they consume the beer in the public-house they get the measure they ask for.

6297. When they send a jug they get a double pull?—Yes, which is generally half as much again or a little more.

6298. (*Chairman.*) 50 or 60 per cent. above the quantity they ask for?—Yes.

6299. They pay for a pint and get nearly two?—Yes.

6300. If drunk on the premises they get only the pint?—Yes.

6301. (*Dr. Whitelegge.*) Can you say how many of the 143 cases noted in your table as occurring in 1900 proved fatal?—Seventeen.

6302. (*Chairman.*) In the other cases would the cure be complete or is the constitution broken for life?—In some of the cases the paralysis apparently is permanent; paralysis of the legs and paralysis of the arms.

6303. (*Sir William Church.*) One has not had time yet to say whether it will be permanent. You will admit that paralysis from peripheral neuritis and paralysis arising from other causes, diphtheria, for instance, sometimes takes many months before it improves, and still more months before recovery is complete, but in most cases eventually becomes complete?—In most of them they certainly do, but some of them are very inveterate at present. Some of them have been under treatment for more than a year.

6304. (*Chairman.*) You use the expression "ordinary alcoholic neuritis"; do you consider that now should be modified in the light of later knowledge?—I certainly think that arsenic accentuates the symptoms of alcohol in producing neuritis to a very marked extent, but I am not at all convinced that you cannot have alcoholic neuritis without arsenic at all.

6305. The peripheral symptoms and paralytic symptoms?—Yes.

6306. (*Dr. Whitelegge.*) You mentioned three fatal cases attributable to Addison's Disease, which now you think probably were due to arsenic?—Undoubtedly they were.

6307. How would these cases appear in the Registrar-General's returns? Does the certificate of Addison's Disease remain?—Yes.

6308. (*Sir William Hart-Dyke.*) Would you rather wish to suggest to the Commission there is peripheral neuritis that may exist from pure alcoholic excess?—Yes.

6309. And there may be a disease where that exists, but very much accentuated and increased in its intensity by the presence of arsenic?—That is my opinion.

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6310. There are two types as it were. The type you were aware of before this scare existed, that is to say alcoholic poisoning?—Yes.

6311. But you have discovered since this scare that the mischief which may accrue to a patient from drinking too much alcohol may be accentuated enormously by the addition of small quantities of arsenic?—Enormously so. The presence of arsenic will produce very serious symptoms if in the presence of alcohol.

but danger enormously increased by small quantity of arsenic.

6312. Would you inform the Commission if these same forms of paralysis may arise from arsenic without any alcohol at all?—Yes, they may.

6313. (*Chairman.*) With regard to the amount of arsenic in beer, what have you to say?—In some of the samples of beer examined by the Public Analyst of Liverpool as much as 1½ grains of arsenic to the gallon was found. This, of course, was an extreme amount, and the general adulteration varied from one-thirtieth grain to one-tenth grain of arsenic per gallon. In one particular case of acute arsenical poisoning a man who had previously been a teetotaller for six months drank forty-two pints of beer in two days. On the second day afterwards he was seized with all the symptoms of acute poisoning, and on admission to hospital was very seriously ill. On examination of his urine arsenic was found in large quantity. The symptoms passed off rapidly, and within a fortnight he left the hospital quite cured. This is an example of a large amount of arsenic having been taken into the system in a short period of time, but in the great majority of the cases small quantities of arsenic had been taken spread over a prolonged period. In many cases patients would only admit to having taken small quantities of alcoholic liquors. The symptoms and appearance have been so ably and fully described by various observers that it is not necessary to refer to them here, but I have observed a few interesting points which, so far, have not to my knowledge been recorded.

Quantity of arsenic in Liverpool beer.

6314. (*Sir William Church.*) In the case of this man who drank 42 pints of beer in two days, the symptoms were gastro-intestinal?—Yes, and sensory symptoms too, very marked. Those were his chief symptoms.

Amount of beer drunk by patients.

6315. But not followed by any permanent paralysis?—Not by any paralysis. His chief symptoms were extreme pain in his hands and feet.

6316. (*Dr. Whitelegge.*) Were those met with in the acute cases?—Yes, always.

6317. (*Chairman.*) Did the paralysis come after the two days drinking?—He had no paralysis. He had extreme pain in the superficial nerves, but he has quite recovered.

Neuritis without paralysis.

6318. He had acute pain, neuritis, but not paralysis?—Yes, and no paralysis.

6319. Not many cases were met with taking small quantities of alcoholic liquors?—Beer and stout. Some of the patients had certainly only taken two pints of beer a day and two bottles of stout a day for some months.

Poisoning from small quantities of beer.

6320. Two bottles of stout would be about two pints, or a little more?—Yes.

6321. Did those patients who said they had only taken small quantities show signs of arsenical poisoning?—Yes; that was during the arsenic epidemic.

6322. (*Dr. Whitelegge.*) Were the cases which you have associated with very small consumption of beer severe cases or slight?—Some of them very severe.

6323. You are not inclined to affirm any direct connection between the amount used and the severity of the symptoms, without regard to the personal equation of course?—I do not think it has any bearing at all, taking into account the length of time they take the small quantities.

6324. (*Chairman.*) Assuming that it was true they had taken only a small quantity, the effect seems to have been accumulative with regard to arsenic?—Yes, and I think that is the important point.

6325. With respect to pigmentation?—Two kinds of pigmentation are met with in arsenical poisoning—one, which is a general darkening of the whole surface of the body, does not desquamate. This appears slowly and disappears very slowly. The other form is one in which the skin becomes dark in colour rapidly, especially attacking the flexures, the breast,

Arsenical pigmentation of two kinds.

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and the front of the abdomen. The epidermis desquamates freely, and can be pulled off, leaving a normally coloured skin underneath. The first variety of pigmentation was met with in the earlier part of the epidemic; the second class only towards the end of the epidemic; and to my mind it seemed to suggest some rather serious increase of the contamination of beer.

6326. (*Chairman.*) Might it not be that they have been under the influence of contaminated beer longer? It might have been but I could not answer that for certain.

Return of symptoms though no fresh arsenic taken.

6327. Have you noticed any relapse?—I have noticed in two cases under my care at present a complete relapse of all the symptoms. The patients were apparently well; pain had disappeared, and the desquamation of the skin had been complete when, without any warning, a fresh attack of neuritis developed, as acute as before, with a general discolouration and desquamation of the skin.

6328. (*Chairman.*) Without more drinking?—Certainly. They had been in hospital all the time.

6329. (*Dr. Whitelegge.*) They were not taking iodide?—No.

6330. (*Sir William Church.*) In connection with these cases, did you make any examination of the urine during that time?—In both these cases arsenic was found in the urine shortly after admission.

6331. I mean at the time they relapsed?—No.

6332. Was it examined?—It was examined, but nothing was found.

6333. (*Chairman.*) No arsenic was found in the urine at the time of the relapse?—No.

6334. (*Professor Thorpe.*) With respect to the statement of this particular form of pigmentation you described which only occurred towards the end of the epidemic, and in your mind suggested some serious increase in the contamination of beer, what period of time do you mean of the epidemic?—Towards the last six weeks of the epidemic.

6335. What particular date would that be?—About the second week in December. We did not notice any desquamation of any case until the second week in December.

Arsenic in urine.

6336. (*Chairman.*) Have you found arsenic in the urine in any cases?—I have been able to find arsenic in the urine in six cases out of 34 examined, but in no case was I able to find it after ten days from admission. I think Professor Dixon Mann has found it much later than that.

6337. (*Sir William Church.*) I ask with regard to these two cases. Dr. Dixon Mann has had certain cases in which there was a sort of relapse, but unfortunately in his case the urine was not examined?—Both mine were at once, and nothing was found.

6338. (*Chairman.*) What tests did you make?—I used the Reinsch test.

6339. With a considerable quantity of the urine?—I took 20 ounces of urine and evaporated it down to four slowly.

6340. So that that would be a very sensitive test?—I think that is the best test for urine.

Beer the common cause of alcoholic neuritis, spirits rarely.

6341. With regard to the cause of peripheral neuritis in general?—With regard to the cause of peripheral neuritis in general, I am of opinion that beer and porter are by far the commonest causes of the disease, yet I have seen undoubted cases caused by spirit-drinking. It is extremely difficult to get a reliable history of drinking from many patients, but I have had undoubted cases where the disease was produced purely by spirits. I have also seen cases of peripheral neuritis caused by the medicinal administration of arsenic in disease; these symptoms, however, have quickly passed off on the cessation of the drug.

6342. In the peripheral neurities that you allude to now as resulting from spirits and not beer, was there paralysis?—Yes, marked paralysis.

6343. So that there is always paralysis in what you call peripheral neuritis?—Generally, yes.

Keratosis common at end of epidemic.

6344. (*Sir William Church.*) With regard to this desquamation, did none of your cases present symptoms of keratosis?—Yes, large numbers.

6345. Did not any of the earlier cases present it?—No.

6346. Only the late ones?—Yes.

6347. So that there was no crust coming away from your early cases?—No; there was nothing to distinguish the early cases from the ordinary cases we have seen for years.

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6348. (*Chairman.*) What are your general conclusions?—After a careful observation of the epidemic I have come to the conclusion that the sensory symptoms are more pronounced in arsenical neuritis than in ordinary alcoholic neuritis, and, although very severe at first, they soon pass away. The motor symptoms tend more quickly to recovery under treatment than the purely alcoholic cases, and most of my patients have completely recovered, although a few are making little progress. When one considers the enormous number of people who have been drinking this beer, which has in some cases in Liverpool contained 1½ grains of arsenic to the gallon, one is bound to think that some people are more susceptible to arsenic than others, as only a very small proportion has been attacked. It is apparent, too, that arsenic is a cumulative poison to some extent. It would seem also that the action of arsenic in the system is more virulent in the presence of alcohol then when given alone. So far as Liverpool is concerned the epidemic is at an end, and I have not had a new case of arsenical poisoning during the last nine weeks. It is just possible that with greater care in the manufacture of beer alcoholic neuritis may become much less frequent, and I have noticed that since the epidemic of arsenical poisoning in Liverpool the amount of alcoholism has very much decreased, a state of matters which I sincerely hope will continue.

Individual susceptibi to arsenic

Decrease "alcoholis in Liverp since the epidemic.

6349. Does that result from less excess in drinking?—I think so. I think it has given the community a great fright—at least we have noticed that in admissions to the hospital.

6350. (*Dr. Whitelegge.*) You say that the amount of alcoholism has decreased very much?—Yes.

6351. On what ground do you come to that conclusion?—On the admissions to the hospital. My hospital is confined entirely to the very poor, and the ordinary admissions suffering from alcohol are certainly very much less than they were.

6352. Including the remote effects from alcoholism?—Yes; general diseases which are produced by alcohol or accelerated by alcohol.

6353. For instance cirrhosis and ascites?—We have not noticed that so much, but ordinary delirium tremens, and things of that sort.

6354. You are thinking of groups of diseases in which there is already time for any recent causation to have made itself clear?—Yes. I do not know what the ultimate effect will be.

6355. Do you now regard alcoholic neuritis as existing apart from arsenic?—In my opinion, certainly.

6356. And with regard to the alcoholic neuritis which may exist apart from arsenic, do you attribute that to beer and porter rather than spirits?—In the majority of cases certainly.

6357. So that if arsenic were eliminated entirely from malt liquors, alcoholic neuritis would be a reality?—I think so, if taken in excess.

6358. And connected with malt liquors rather than with spirits?—Yes, if taken in excess.

6359. You told us of cases in which relapse occurred. Can you say at what interval the relapse occurred?—Ten weeks.

6360. (*Sir William Church.*) That leads me to ask one other question. If you think that alcoholic neuritis is more frequently produced by beer drinking than spirit-drinking why has there been such a large proportion of cases to the population in Liverpool and its neighbourhood, Manchester and Salford, than in London, which is a beer-drinking population?—In Liverpool and Manchester I think a very large amount of beer is consumed as compared with spirits.

6361. I am speaking of before beer was thought to be contaminated, in years gone by?—I cannot explain that.

6362. You would not like to express an opinion that the population there drink even more beer than in London?—No; I do not know at all.

6363. (*Chairman.*) Do you not think that some of the now known causes may have existed occasionally to a considerable degree in old times; that is to say, that some of those cases which are so closely analogous to the arsenical poisoning in their symptoms may have been due to unsuspected arsenic in the beer?—It is

quite possible that some of the symptoms may have been produced by very small quantities of arsenic spread over prolonged periods, but, of course, recently undoubtedly the arsenic has been in very large quantities, and so accentuated the symptoms.

6364. (*Dr. Whitelegge.*) Can you give us the proportion of the sexes in these cases?—I have the proportion as regards 132 cases, and I sent them to Dr. Buchanan, for his report to the Local Government Board.

West Derby Union Infirmary, Liverpool.—Age and Sex of Peripheral Neuritis Cases.

——	Under 10.	20-	30-	40-	50-	60-	70 and upwards.	All Ages.
Males - -	—	5	12	17	6	3	—	43
Females -	1	7	39	29	10	3	—	89
Total -	1	12	51	46	16	6	—	132

6365. (*Chairman.*) Have you any evidence as to the number of deaths from the epidemic in the Manchester and Liverpool district, or the number under your own cognisance?—I have had 17 during the epidemic, and I have had 51 cases which have ended fatally out of the total number of cases. The 17 undoubtedly died from arsenical poisoning.

6366. (*Professor Thorpe.*) During this epidemic?—Yes.

6367 (*Chairman.*) Does anything else occur to you to tell us?—Bearing on the question which you yourself suggested, I have had four years' experience in charge of one of the large Scotch hospitals, and your remarks are certainly very important, because I saw only four cases of neuritis there out of 10,000 admissions. Beer was taken in very small quantities.

6368. That is a much smaller proportion than in Liverpool and Manchester before this large outbreak?—Extremely small.

6369. There was a larger proportion of neuritis than in Scotland before this outbreak?—Very much smaller percentage in Scotland, because they generally take whisky. *Dr. N. Raw,* 27 Apr. 1901.

6370. And that was before the time of this outbreak?—Yes; I am referring now to seven years ago.

6371. (*Dr. Whitelegge.*) Where was that?—Dundee Royal Infirmary.

6372. Would the class of population make any material difference? The one is a Poor-law infirmary and the other a general infirmary?—The class of the population was almost the same, the working class.

6373. (*Sir William Church.*) Could you inform the Commission whether, in your opinion, beyond paralysis different sorts of alcoholic drinks appear to have rather different effects upon the human body?—In my opinion the neuritis which is caused by spirits is rather more paralytic in nature.

6374. Quite apart from neuritis, are there any other effects produced on the human body which are attributed to alcohol, and which differ a good deal in different parts of the kingdom? Perhaps you have never been much in London?—No, I have not.

6375. Are you aware that so-called gin-drinkers' liver which used to be attributed to the use principally of gin is found in Scotland?—Yes; I do not know how frequently, but it is fairly common there. The other lesions you find in the body are just as common in Scotland as in England, in my experience.

6376. Your experience is contrary to that of a great many others with regard to cirrhosis of the liver, hobnail liver, gin-drinkers' liver. It used to be very uncommon in Edinburgh years ago?—I do not know.

6377. (*Professor Thorpe.*) Is the gin-drinkers' liver common in Liverpool?—Not very common. I saw more gin-drinkers' liver in Scotland than in Liverpool.

6378. (*Dr. Whitelegge.*) Contracted liver?—Yes. Cirrhosis of liver common there.

6379. You have met with this in Scotland in association with whisky?—Yes; in many cases.

Mr. George E. Davis, called; and Examined.

6380. (*Chairman.*) You are chemical engineer and consulting chemist of the Manchester Technical Laboratory?—Yes. *Mr. G. E. Davis.*

6381. You have given us a statement, for which we are very much obliged to you, which will appear in our report?—Yes.

(*The following is the statement*):—

In order to thoroughly understand the present position of the sulphuric acid industry it is necessary to go back to the year 1870, when the trade was of much smaller dimensions than it is to-day.

In that year the manufacturers of sulphuric acid might well have been divided into two classes:—

(1) Those who manufactured the acid for their own uses, such as the alkali makers and the makers of phosphatic manures, and

(2) Those who manufactured the acid for sale to ordinary customers.

In the first class, but little other than Spanish pyrites was employed, and the two kinds of this ore mostly used were Mason's and Tharsis. At that time or soon after, the Rio Tinto mines were offering cargoes, but as the acid makers had become used to the manipulation of the Mason and Tharsis ores the Rio Tinto ore did not find much favour.

Moreover it was freely stated that the Tinto ore contained more arsenic than either Mason's or the Tharsis, and the influence of this upon the extraction of the copper that these pyrites contained was so uncertain that most vitriol makers preferred to use pyrites they did not know something of, rather than change to a source of which so little was known.

Then, again, this period was one in which a transition was being effected from an old method of working to a new. In the old method the kilns and chambers formed the whole of the vitriol plant, with in some cases a small steam tower at the end of them to prevent large escapes of gas into the atmosphere. In the new method (which was then so new that practically only a few of the alkali and manure makers had adopted it), a Gay-Lussac tower at the end of the chambers, absorbed in strong sulphuric acid the nitrous fumes that formerly went into the atmosphere, and this acid was employed in another tower, called the Glover tower, to furnish nitrous fumes, that were led into the chambers with a flow of gas from the pyrites kilns. This tower was placed between the pyrites kilns and the first sulphuric acid chamber.

In 1871, in a works in South-East Lancashire with which I was connected, the new method was employed, and Mason's ore was used as the raw material.

This Mason's ore in 1871 contained 0·42 per cent of arsenic, and the sulphuric acid made from it contained at 140° Tw. or 1·7 sp. gr.:—4·3 grms. per litre of As_2O_3=3·2 grms. per litre of As, or 0·19 per cent. As.

Upon going to St. Helens in 1874 the two works to which I was attached worked on the old system. Tharsis ore was burned here which contained 0·32 per cent. arsenic.

In these works there were no Glover towers, but a long and large iron flue intervened between the pyrites kilns and the vitriol chambers. In this flue a large quantity of the arsenic was condensed as As_2O_3, and this was removed about once in six months. The deposit in this flue was very arsenical, as it contained over 54 per cent. of arsenic trioxide as well as some antimony and bismuth.

The acid made in these works contained:—2·26 grms. per litre of As_2O_3=1·72 grms. per litre of As.=0·11 per cent. of As.

In another factory in the same town burning Tharsis ore (in 1875) the heat from the burning pyrites was utilised for concentrating the chamber acid by passing the flames over its surface, in a pan at the end of the pyrites burners, between them and the leaden chambers. In this case there was no flue in which the arsenic could deposit, and the sulphuric acid consequently contained more arsenic than usual, but not much more.

It was 2·66 grms. per litre As_2O_3=2·02 grms. per litre As=0·12 per cent. As.

In what was the new system of working in 1870-7 the Glover tower placed between the pyrites kilns and the first leaden chamber acted practically as a washer and

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scrubbed the major portion of the arsenic from the gases by means of the vitriol that was showered down it. This is precisely the method of working to-day, and when the whole of the acid made in the establishment is poured down the Glover tower, the acid issuing from the tower contains the whole of the arsenic volatilised from the burning pyrites. The tower itself, however, does not wash out the whole of the arsenic from the gases; some arsenic goes forward into the first chambers of a series. But as this acid eventually finds its way down the Glover tower, it will be evident that the total arsenic is found in the outflow from the tower.

Arsenic in Glover tower acid and in chamber acid.

During some investigations relating to the distribution of arsenic in a sulphuric acid plant, which I made in 1872, it was found that when the acid running from the Glover tower contained 4·3 grammes per litre of arsenious acid, the acid in the first chamber contained 1·6 grammes per litre, 0·3 grammes per litre in the second chamber, and mere traces in the last two chambers.

Of course it will be seen that if acid is taken out of the chambers without passing down the Glover tower, it will not be charged with its normal average amount of arsenic, and the acid running from the tower will then be more highly charged with arsenic owing to the smaller volume, and in such cases the percentage of arsenic is very high.

In one case that came under my notice the hot acid from the Glover tower contained 18·0 grms. per litre of arsenious acid when Rio Tinto pyrites was being used.

In the seventies, small quantities of coal pyrites (called "brasses") were burned, but the quantity was insignificant in works of the first class.

Arsenic in different pyrites ores.

To-day the chief source of pyrites material is the Rio Tinto. This ore contains 0·40 per cent. of arsenic, and is very regular in its composition. Tharsis pyrites is burned still to a certain extent, Mason's to a very small extent, and there are several other mines sending their products to this country and known by various trade names, such as "Seville," "Santa Rosa," "Norwegian," etc.

Seville ore is very arseniferous; it contains 0·9 per cent. of As.

Santa Rosa is still more arseniferous, and often contains as much as 2·24 per cent. of As.

Sulphuric acid made in 1897 from Rio Tinto pyrites under my superintendence contained:—4·8 grms. per litre of As_2O_3 = 3·6 grms. per litre of As. = 0·21 per cent. As.

Norwegian ores are very variable in their composition. Some are free from arsenic, other varieties contain arsenic and copper, while some kinds contain so much selenium as to unfit them for many industrial purposes.

I may now pass to the second class of manufacturers, who, in 1870-80, manufactured the acid for sale to ordinary customers.

Acid from Sicilian brimstone.

At this time, say 1871, most of the acid sold was rectified, water-white, vitriol of a sp. gr. of 1·840 or 164° Tw. Even when the acid was required by the consumer to be employed in the diluted state, he as a rule preferred the rectified acid, and to dilute it with water to his requirements. The two kinds in the market then were known as brimstone acid and pyrites acid. The brimstone acid makers used Sicilian brimstone, and the contracts were nearly universally made for "Sicilian brimstone," "Best Thirds," and it was from this quality that the whole of the "brimstone" acid was made in those days. At this time, 1871, and perhaps a few years before, sulphuric acid began to be made from spent oxide of iron, the refuse from gas works, and this was by many people regarded as a very fair substitute for brimstone acid in many cases. It had at that time no special designation, and at times it was not altogether free from arsenic. It had, however, a ready sale as it was a clean good acid, and for sulphate of ammonia making gave a good grey sulphate, which pyrites acid would not do.

from spent oxide.

From 1871 to 1877 the manufacture of sulphuric acid from spent oxide underwent considerable expansion, and the acid was a serious competitor with brimstone acid, so much so that the makers of brimstone acid went about to their customers decrying the acid made from "gas works refuse," as they called it; and several of them instructed their customers that such acid was not "brimstone" acid, and therefore ought to be classed with pyrites acid, which was lower in price.

This state of affairs was put before me in 1878 by a firm then making about 80 tons per week of sulphuric acid from spent oxide, and I advised them that although most of the acid made from spent oxide was every bit as good as that made from "best thirds Sicilian brimstone," yet by no stretch of the imagination could it be 'brimstone acid,' and I advised that it should be called 'sulphur acid,' as spent oxide from gas works contains its sulphur in the free state. So it was called sulphur acid in many places, to distinguish it from brimstone acid on the one hand and pyrites acid on the other. Some works have called it oxide acid, and both these designations mean the same thing.

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Pyrites use in recent years more arsenical than formerly.

The extension of the manufacture of acid from spent oxide continued until the year 1886, when spent oxide became scarce, and its price tended upwards.

This set some manufacturers thinking that if the arsenic could be extracted from the vitriol during manufacture, lower grades of pyrites (that is ores containing more impurities, notably arsenic) could be profitably dealt with. These ores are those already mentioned such as the Seville and Santa Rosa. This was effected on a very large scale, and in 1887 began a movement which has not only had a serious effect upon the "sulphur" acid trade, but has nearly civilised "Brimstone" acid out of existence.

No arsenic in genuine brimstone acid and traces in spent oxide acid.

I have examined many samples of genuine brimstone acid and found them always arsenic free.

I have also examined many samples of sulphur acid made from spent oxide, and while they have been generally free from arsenic, many samples have been found to contain arsenic, but in traces only, often very minute traces.

I have also examined a very large number of samples of pyrites acids, but the results already given will sufficiently indicate their arsenic contents.

The arsenic existing in pyrites is found there as metalloid arsenicum in combination with some heavy metal, generally copper, iron or nickel. When such a pyrites is burned in a current of air some of the arsenic is oxidised and volatilises; 70 to 80 per cent. of the arsenic leaves the pyrites on combustion. It has already been shown that when a long and cool flue intervenes between the pyrites kilns and the leaden chambers, some of the arsenious acid condenses therein, but still a large quantity passes on and finds its way into the acid of the chambers.

Under the modern system of working the interposition of the Glover tower between the pyrites kilns and the leaden chambers causes a very large proportion of the arsenic to be absorbed in the vitriol that is run down it, and this amount is kept out of the leaden chambers, so that the acid drawn from the chambers is much less arsenical than the Glover tower acid. It is certainly less arsenical than it would be if the Glover tower had not been interposed.

Solubility arsenic in vitriol greater at high temperature.

The vitriol running from the Glover tower is very hot, generally, 300° F. to 320° F., and usually of a sp. gr. of 1·75 or 150° Tw. At this temperature and strength a litre will dissolve about 60 grammes of arsenious oxide, or equal about 2·58 per cent. by weight of metalloid arsenic. When, however, this arsenical acid is cooled down to the ordinary atmospheric temperature the greater portion of the arsenious acid crystallises out, and a saturated solution containing about 10 grammes per litre of arsenious acid is supernatant. This is equal to 0·57 per cent. by weight of arsenious acid, or 0·43 per cent. of metalloid arsenic.

I have seen it stated in print during the past few months that a vitriol of commerce was found to contain 1·8 per cent. of arsenic, or four times as much as the above figures show an acid can hold in solution. This can be accounted for by the fact that the arsenious acid which crystallises out during cooling has not been allowed to settle out before sale.

There is also a further explanation. The arsenic existing in sulphuric acid made by the modern method occurs in two forms: arsenious acid and arsenic acid. The arsenic acid is more soluble in sulphuric acid than the former is.

The foregoing experiences show that it would not be difficult to so arrange the apparatus that from 70 per cent. to 80 per cent. of the arsenic contained in very arsenical sulphuric acid would be eliminated by cooling and subsidence. No invention would be required, but simply the application of known facts.

In all the works where pyrites vitriol is "de-arsenicated" the operation is performed by diluting the vitriol

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with water and precipitating the arsenic as sulphide by contact with sulphuretted hydrogen gas.

When the sulphuric acid is sufficiently diluted and kept cool it is possible to eliminate the whole of the arsenic, if the operation is properly conducted. Such acid is even better than acid made from brimstone for many purposes, as the sulphuretted hydrogen gas also purges the acid of its nitrous contents, which are very detrimental in some processes, such as the manufacture of aerated waters and the preparation of some colouring matters.

Irregularity of working cannot, however, be thoroughly guarded against in the de-arsenication of pyrites acid without much care in the supervision of the operations. The precipitate of arsenious sulphide is a very bulky one, and much sulphuric acid is entangled with it. It would not pay to lose this, and so the precipitate is washed and sometimes heated to facilitate the subsidence of the arsenious sulphide. During any process of heating some arsenious sulphide and also some antimony that accompanies the arsenic is re-dissolved, and if this solution is mixed with the bulk of the de-arsenicated acid arsenic will be found in the so-called purified acid.

There is one other point that deserves to be mentioned. The more arsenic in the raw acid the greater will the bulk of the arsenious sulphide precipitate necessarily be, and consequently the greater trouble in the manipulations. When an acid maker sells two qualities of acid, viz., an arsenical acid and a de-arsenicated acid, it is to his interest to concentrate as much arsenic as possible into his common or arsenicated acid, say the Glover tower acid, so as to have less in his chamber acid to precipitate. In such a case the untreated acid would contain far more arsenic than the average acid of a maker who did not de-arsenicate at all. For some purposes perhaps this would not matter, but it is not a step in the right direction.

In 1878 I carried out a series of experiments for a firm, with which I was then connected, of eliminating the arsenic by means of a stream of hydrochloric acid gas, but it was found that it was only the arsenious acid that was eliminated. The arsenic present as arsenic acid still remained, and the process was discontinued as an imperfect one.

When arsenical sulphuric acid is used for the preparation of other acids the arsenic generally contaminates them. In 1876 a sample of phosphoric acid sent to me for analysis contained 2·6 grammes per litre of arsenious acid, and a sample of liquid muriatic acid recently examined contained 1·12 grammes of arsenious acid per litre. This last acid was made with sulphuric acid, the produce of Rio Tinto pyrites.

6382. (*Chairman.*) With respect to some of the chief points of your statement, we understand formerly the vitriol plant consisted essentially of kilns for burning the pyrites and chambers for making the acid, with the long flue to the kilns, in which a good deal of the arsenic condensed?—That was so.

6383. The introduction of the Glover tower in connection with the Gay-Lussac tower meant that in between the kilns and the chambers a washing tower was interposed?—Yes; that was called the Glover tower. It was for the purpose of boiling down the acid from the chambers. The acid was weak as it came from the chambers, and contained a great deal of water, and formerly, prior to 1870, it used to be boiled down in leaden pans, but the Glover tower was an invention to boil down this acid by means of the waste heat coming from the pyrites.

6384. The washing in this tower is done by sulphuric acid, which is continuously passed back from the chambers?—Yes.

6385. The washing in the tower takes up a large proportion of the arsenic?—Yes.

6386. In which of the substances concerned is the arsenic taken up?—The arsenious acid is in the state of vapour carried along with the sulphurous acid from the sulphur of the pyrites and the arsenious acid being a solid substance, whilst the other is a gas, the vitriol poured down this tower washes out the arsenic.

6387. Where does the arsenic washed out go?—Into the sulphuric acid.

6388. The Glover tower acid is thus highly arsenical?—It is.

6389. While chamber acid is much less arsenical?—

6390. And the amount of the arsenic diminishes from chamber to chamber?—Yes.

6391. The effect of the Glover tower has been on the one hand to enable pyrites acid from the chambers to be comparatively free from arsenic?—Yes, about one-third of the quantity that exists in the tower acid.

6392. On the other hand, it has caused the production of a commercial sulphuric acid from the Glover tower, which is much more arsenical than was made previously?—Yes.

6393. Are the acids from the chambers and from the Glover tower about equally strong as regards sulphuric acid?—Yes, about an equal strength of real sulphuric acid, or to be more exact, the chamber acid contains about 70 per cent. of sulphuric acid while the Glover tower acid contains 80 per cent.

Ores coming into the markets increasingly arsenical.

6394. The cheaper and more arsenical ores, such as Seville and the Santa Rosa, are coming into the market as well as the Rio Tinto ore; formerly it was Rio Tinto?—Nearly entirely; but now the Rio Tinto are putting up their price, and the world will be now searched for ores, perhaps not quite so pure.

6395. The Rio Tinto ore was a sulphuret of copper?—Yes, and iron.

6396. Which the most, iron pyrites or copper pyrites?—The iron pyrites, a bi-sulphide of iron.

6397. Is there much earthy or rocky matter along with this ore, or does the pyrites come out nearly free from earthy matter?—There is not very much impurity in the ore. I think the full amount of sulphur it can hold theoretically is 52 per cent., whereas it contains from 49 to 50.

6398. Which contains?—The ore contains from 49 to 50 in practice, and it can only hold 52 theoretically, so that it is very nearly pure pyrites.

6399. When very arsenical ores are used, the manufacturer makes both arsenical and non-arsenical acid?—Generally.

6400. And he has a special reason for trying to get as much arsenic as possible into his Glover tower acid?—Yes, when he de-arsenicates.

Tower acid not in practice de-arsenicated.

6401. Does he de-arsenicate the Glover tower acid generally?—Not if he can help it, because it contains too much arsenic.

6402. Why does not he?—When the sulphuretted hydrogen is passed through this strong acid, there is so much sulphide of arsenic that perhaps two-thirds of the settling-tanks would be filled with this material, and he would be only able to draw off from these tanks about one-third of the acid he treated.

6403. What remains in the mud, has that to be got out?—Yes. And that is why he would rather not treat this strong acid.

6404. He could purify the whole of it?—Yes.

6405. Is it an expensive process?—Much more expensive than treating the chamber acid only.

6406. Treating the chamber acid to purify the arsenic is not a very expensive process?—No, because there is a small quantity of arsenic in it.

Cost of de-arsenicating chamber acid.

6407. It makes a very small difference on the price of the finished product to purify it from arsenic?—I think I have read some of the evidence, but I think it is minimised rather. It does cost a few shillings per ton.

6408. Two or three shillings?—It might go up to 5s.

6409. 5s. out of 45s. perhaps?—Yes. It would vary, perhaps, from 1s. to 5s., according to the amount of arsenic that is present in the acid.

6410. What do they do with the Glover tower acid—sell it?—It is sold to these people, to whom arsenic is no damage, such as the manure makers.

6411. Is arsenic no damage to them?—I have not followed the question out.

6412. Would not putting so much arsenic into the manure make it liable to get into the roots, or even into the plants?—I have not followed that subject out.

6413. The arsenic found in the refuse of the Glover tower acid is not a product of any value?—No, not at present. It has been tried to utilise it, and I think one or two manufacturers do in a small way, but I don't think there is any great use for the whole of it.

6414. It is sulphide of arsenic?—Yes, it is.

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6415. Arsenium and sulphur?—Yes.

6416. It would be a dangerous thing to throw out?—It is very insoluble. I do not think it would do much harm on an ordinary waste heap.

6417. Could you get quit of it in a rubbish heap?—Yes, in the ordinary rubbish heap of the works, which is a mixture of everything.

Sulphuric acid super-saturated with arsenic,

6418. The Glover tower acid when hot can dissolve about six times more arsenious oxide than when cold; is that so?—Yes.

6419. Hence when we have been told of a commercial acid in which a deposit of crystallised arsenious oxide was found, we may infer that the amount of arsenic might have been materially diminished by simply cooling and decanting?—That is so.

may be sold without declaration.

6420. And such acid may be sold without a special note that it contains arsenic?—Yes; I do not think any note is made as a rule in selling acids, whether it contains arsenic in any greater or less degree.

6421. That would be highly poisonous if, by chance, a few drops of the sulphuric acid was used in medicine and various ways?—Very poisonous indeed. It ought not to be used for food.

6422. Do you know whether sulphuric acid is used in any acidulated drops or other confectionery?—I think vegetable acids are used for that, citric and tartaric.

Citric and tartaric acids liable to be arsenical.

6423. Is sulphuric acid ever used for cheapness; it is as wholesome as any other if it is not too strong?—I do not think it is used because there is a peculiar taste about the vegetable acids. On the other hand citric and tartaric acid are both made with sulphuric acid as a basis, and the arsenic in sulphuric acid would probably get into the citric or tartaric.

6424. Would you approve of allowing what you call Glover tower acid to be sold at all without a notice that, although called sulphuric acid, it contained a large amount of arsenic?—I think so. I think it should be used for certain purposes. I think caution should be exercised by the people who are going to use it.

6425. It does seem rather dangerous to sell a sulphuric acid without note or comment, a liquid containing as much arsenic in solution?—It is dangerous for food stuffs.

Arsenic acid in sulphuric acid.

6426. Cooling the sulphuric acid from the Glover tower process would not remove much of the arsenic which is present as arsenic acid?—No; it would remove none that was present as arsenic acid.

6427. It would remove crystals of arsenious acid?—Yes.

6428. How is the de-arsenication of chamber acid effected? Is that by the aid of sulphuretted hydrogen?—Yes, that is how it is done at present.

6429. Diluting and precipitating. Is there any other substance required to precipitate it?—No.

6430. You simply dilute the acid and precipitate by sulphuretted hydrogen gas?—Yes.

6431. Must the acid be diluted?—Yes, because arsenic is not wholly precipitated without you reach a certain degree of dilution; in the strong acid precipitation does not take place.

6432. The result is completely arsenic-free acid, but considerably diluted with water?—Yes.

6433. Is it not rather an expensive process to dilute the acid, precipitate the arsenic, and afterwards strengthen the acid?—No. It only costs, I should think, on an average, something like 3s. 6d. a ton.

6434. Does that include the re-strengthening of the acid?—Yes.

6435. Is it possible in this way to produce a completely arsenic-free acid?—It is.

6436. Can arsenic-free in this sense mean that no arsenic could be found by any test in a quantity such as an ounce of acid?—Yes; it could be entirely precipitated from it.

Arsenic can be completely removed from chamber acid.

6437. With regard to arsenic in brimstone acid and spent oxide acid, have you found brimstone acid made from Sicilian sulphuric uniformly arsenic-free?—Always; when I have been able to prove to my own satisfaction that the acid has been really made from Sicilian brimstone it has been always free from arsenic.

6438. Have you ever found any arsenic whatever in sulphuric acid made from Sicilian sulphur?—No, I have not.

6439. Have you tested a great many samples?—A great many.

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6440. We have been told that it is sometimes found in acid made from Sicilian brimstone?—I have found arsenic in acid which has been sold as brimstone acid, but which afterwards I found out had been made from something else.

Sicilian brimstone acid always free from arsenic.

6441. What else?—The spent oxide from a gas works, and coal pyrites.

6442. Spent oxide gives you sulphur?—Yes.

6443. But mixed with some other impurities?—The first sample I ever tested of spent oxide acid contained traces of arsenic, and I followed the whole question up, and I found it was due to hydrochloric acid containing arsenic having been used to prepare the oxide of iron that went into the gas works in the first place.

Origin of arsenic in spent oxide acid.

6444. How much sulphur is there in the spent oxide supplied for this purpose?—It varies from 40 to 55 per cent.

6445. Which may have been contaminated by arsenic in the way you described?—Yes, sometimes.

6446. The arsenic is introduced through impure hydrochloric acid, but by using pure hydrochloric acid in the process the spent oxide sulphur would be free from arsenic?—Yes, quite free.

6447. That is a by-product from the gas works?—It is.

6448. Is any process of de-arsenication carried out at any works which produce brimstone acid or spent oxide acid?—No; it is not necessary.

6449. It is generally considered that the sulphuric acid which is produced, whether from brimstone or spent oxide, is arsenic-free?—It is generally free enough for all practical purposes.

6450. But you say that in a specimen which was called brimstone acid you found arsenic, and traced that back to spent oxide?—Yes.

6451. Then spent oxide without a special test for its purity does not give security against arsenic in the final product?—No; but the quantity is very small, mere traces. It does contain sometimes arsenic.

6452. When sulphuric acid containing arsenic is used for the preparation of other acids, the acid generally contaminates them?—Generally it does.

Arsenic in acetic acid.

6453. In what cases may arsenical acid be used for the preparation of other acids?—Some years ago it was very largely used in making phosphoric acid; it is used in making acetic acid. All these things are matters of history; they are mostly detailed in "Gmelin's Handbook of Chemistry." The arsenic is found in these acids on account of pyrites sulphuric acid having been used for the preparation of these other acids. It is mentioned in Gmelin's handbook that acetic acid has been found in Germany to contain arsenic, which was traced to pyrites acid, and the quantity I found some years ago in phosphoric acid was rather large.

in phospho acid used sugar refin ing.

6454. Derived from arsenical sulphuric acid?—Yes.

6455. That is an enormous quantity that you found in 1876, 2·6 grammes of arsenious acid per litre?—Yes, and that was being sold at that time for sugar refining.

6456. The phosphoric acid was used for sugar refining?—Yes. The juice was treated with lime and the excess of lime was taken out by phosphoric acid.

6457. Was there any poisoning by the sugar so produced discovered?—I daresay in those years it would be put down to neuritis.

6458. With regard to the sugar that was treated by impure phosphoric acid, were there tests known to have been made?—I do not think so.

6459. You found a sample of phosphoric acid ready to be used for purifying sugar?—Yes.

6460. Containing as much as 2·6 grammes per litre?—Yes.

6461. That is a ¼ per cent. by weight?—Yes. In 1876 a sample of phosphoric acid sent to me for analysis contained 2·6 grammes per litre, of arsenious acid.

6462. Of arsenious acid per litre of phosphoric acid?—Yes.

6463. (*Professor Thorpe.*) Do you really mean that?—Yes.

6464. Was it a solution of phosphoric acid?—Yes. In those years it was sold as a liquid concentrated to 140 Twaddle, 1·7 specific gravity.

6465. Phosphoric acid is now usually sold in a solid condition, is not it?—Not for manufacturing purposes. It is for finer chemicals, the glacial, but this was made by treating phosphate of lime with sulphuric acid made from the copper pyrites and then boiling down the liquid resulting from that, after separating the sulphate of lime. One works used to turn out about 20 tons a week.

6466. (*Chairman.*) You found recently a sample of liquid muriatic acid containing 1·12 grammes of arsenious acid per litre?—Yes.

6467. This last acid was made with sulphuric acid, produced with Rio Tinto pyrites?—Yes, and that is a very good average sample.

6468. (*Sir William Church.*) You say that by a process of cooling the Glover tower acid you would get rid of a good deal of the arsenious acid, but the arsenic acid would not be affected by that?—It is about one-third of the total quantity present there as arsenic acid, and if this acid is worked over these towers several times some of this arsenic, as arsenious acid, might separate out in the tanks by crystallisation, but the arsenic acid does not crystallise out. So that if it goes over the tower two or three times, pumped in at the top, and running out at the bottom, although a great deal of arsenious acid is separated out, the arsenic acid is continually increasing, so that that accounts, I think, for some of the acid one has read of in the papers being so strongly charged with arsenic. It was stated at the coroners' inquest that there was 1·8 grammes per litre in some of the acid, and that is a great deal more arsenic than ordinary acid will hold in solution. The only way to account for that is that it was present there as arsenic acid to a great extent, which does not separate out by crystallisation.

6469. (*Chairman.*) Does arsenic acid escape some of the tests that are applied?—It might do, but I do not think it does as a rule. The fact is, that when you pass sulphuretted hydrogen through a solution of vitriol containing arsenious acid and arsenic acid, the arsenious acid is converted into sulphide first, and the arsenic acid that is there does not form a sulphide until a considerable time. First of all, it has to be reduced by the sulphuretted hydrogen going through it to the state of arsenious acid, and then the arsenious acid is converted into sulphide, and that forms a very good practical test when one is de-arsenicating acid, because the sulphuretted hydrogen saturates the solution, and if, after standing a few hours, you find the acid no longer smells of sulphuretted hydrogen you know you have not passed enough through, and that some of the arsenic acid that is there perhaps has not been thrown down.

6470. The precipitation of sulphuretted hydrogen, if conducted long enough, will throw down all the arsenic acid after the arsenious acid?—Yes.

6471. First, the arsenious acid, and then given a continuation of the process, the whole arsenic acid will be thrown down?—It will.

6472. (*Professor Thorpe.*) What do you precisely understand by brimstone acid?—Acid made from Sicilian brimstone.

6473. Would you not understand by brimstone acid, acid made from spent oxide?—Certainly not.

6474. Although, of course, in the spent oxide it is a sulphur from which the stuff is produced?—Yes; but I make a distinction between sulphur and brimstone; brimstone is the native article, sulphur is a manufactured substance.

6475. Is that distinction always recognised in the trade?—It was in those early days.

6476. Is it now?—I would not like to say now. I have not had anything to do with the brimstone trade for 10 or 12 years; but I should not think it was.

6477. It would not be right for a manufacturer to designate as brimstone acid an acid made from sulphur which may be contained in spent oxide?—Certainly not. I should say it was quite a wrong thing to do.

6478. And you think in making that assertion you would be supported by the general opinion of the trade?—I think so.

6479. Taking brimstone acid in your sense, can you tell the Commission the relative proportion of brimstone acid to pyrites acid made in this country?—No, I could not without getting statistics, and those are very difficult to get just now, because many manufacturers make the pyrites acid for their own use, and nobody but themselves have the statistics. It could be only got by taking the total quantity of pyrites coming into this country, and then supposing it was all used for one purpose.

Most pyrites acid used up at place of manufacture.

6480. I presume all the pyrites that comes into this country from those sources, at all events, you have mentioned, is used in the manufacture of oil of vitriol?—I think so; but the bulk of it is used up again in the works where it is produced. It does not go outside to customers at all.

6481. I am quite aware of that. A large quantity is used in the alkali trade and in the manure trade?—Yes.

6482. Therefore it does not go into general consumption?—No.

Acid from recovered sulphur.

6483. Would you call acid made from recovered sulphur brimstone acid?—No; I should call that sulphur acid.

6484. Is that a term recognised in the trade?—Yes, it is always sold as sulphur, and generally recovered sulphur. The acid that was made in those years when brimstone acid was being made to be sold to consumers was always specified in the contracts that it should be Sicilian brimstone, best thirds. There were several qualities of brimstone, firsts, seconds, and thirds. Thirds were divided into one or two grades again. The first was too expensive to make vitriol of, and the second quality was considered to be so, but the best thirds, that is, the first grade of the third quality, was always selected for brimstone making; so that it was a very definite thing in those years. It was best thirds, and the whole of the brimstone acid in those days were made from that quality.

6485. (*Chairman.*) Did the firsts and seconds contain sometimes arsenic?—No.

6486. The best thirds was better quality than the first and seconds?—There was more rock with the third, which they would not have in the first and second quality. The first and second quality was generally 99·9 per cent. of sulphur, but the best thirds was 95 to 97.

German sulphuric acid made from pyrites.

6487. In Germany is the acid made chiefly from brimstone acid or chiefly from pyrites?—Chiefly from pyrites.

6488. Is there much brimstone acid made in Germany?—I do not think so.

6489. Is it easy to get arsenic-free acid in Germany?—Yes, there are de-arsenicating plants working in Germany.

6490. But ordinary German pyrites acid is as liable to contain arsenic, and contains as much arsenic as English made pyrites acid?—Quite so. They have methods of taking it out with sulphuretted hydrogen in much the same way as we have.

6491. They have a Glover tower?—Yes.

6492. And your remarks about the Glover tower and the difficulty of purifying the Glover tower applies equally to the German mode of manufacture?—Yes.

Arsenic common in hydrochloric acid.

6493. (*Dr. Whitelegge.*) At the end of your print you mentioned a large proportion of arsenic being contained in hydrochloric acid; is that general?—Yes, that is very general.

6494. Is hydrochloric acid used much in the preparation of food substances?—It is used a little. In the making of dextrin and even glucose it is quite permissible to use hydrochloric acid.

6495. And when hydrochloric acid is used it is necessary to take the same precautions against the presence of arsenic as in the case of sulphuric acid?—That is so.

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6496. (*Dr. Whitelegge.*) Are those precautions generally taken?—There is another circumstance, if you will allow me. Hydrochloric acid, that is used for food stuffs, as a rule is what is called cylinder acid; that is, it is not made in the ordinary way from pyrites. It is made from brimstone acid in the first place, in cylinders, and in much smaller quantities. Perhaps only two or three tons a week would be made in a cylinder, whereas you would make 150 tons a week in the ordinary furnaces. There is more care taken, and the price is about two or three times that of what is made in the large way, so that when a man wants to use hydrochloric acid for food stuffs he generally buys what is called cylinder acid.

Hydrochloric acid for food purposes should be cylinder acid.

6497. Which would contain a little arsenic?—It would not be contaminated with arsenic if it were made from brimstone acid. The difficulty is in the buyer finding out that it contains arsenic without testing it. That is why I think the onus of the acid being pure should be put upon him. He goes about to the cheapest market to buy as cheaply as he can, and he does not know until it is too late that an acid he is buying is made from pyrites instead of brimstone. He would know it if he were testing the substance he was buying.

6498. You mention that the Norwegian ore occasionally contains selenium?—Yes.

6499. Can you tell us anything about the presence of selenium in sulphuric acid?—It is present sometimes in small quantities, very small quantities indeed. It generally shows itself by volatilising into the hydrochloric acid when hydrochloric acid is made from it. Otherwise you do not find its presence very marked. It has a peculiar property of turning the hydrochloric acid after a time red, and a deposit forms in the carboys in which it is put of a blood-red colour, which people, as a rule, who are not chemists, fancy is iron. I have known of a good many carboys of acid having been returned to the makers with this deposit in the bottom, with the information that they could not use it because of the iron in it. That iron has been found to be selenium.

Selenium in sulphuric acid.

6500. In the sulphuric acid would it make itself felt?—No.

6501. (*Professor Thorpe.*) Has it not a power of turning sulphuric acid a particular colour?—It may have, but that colour is always masked by impurities in the sulphuric acid. In a large works the sulphuric acid is almost always brought into contact with some organic substance, and instead of getting a clear acid it is generally brown from the presence of organic matter.

6502. (*Dr. Whitelegge.*) Would selenium be only found in acid from Norwegian ores?—Yes, in any considerable quantity.

6503. Is much of the sulphuric acid on the market prepared from Norwegian ore?—Not much. It is a very difficult ore to work, and, therefore, it has not found much favour.

6504. So that in general one would not expect to find selenium in any sulphuric acid?—Not in a quantity to do any damage.

6505. Can you say anything as to the proportion in which selenium would be present as a maximum in the Norwegian ore?—No; I have never determined the quantity.

6506. (*Professor Thorpe.*) To come back to where I left off. You told us that sulphuric acid made from recovered sulphur would be known in the trade as sulphur acid?—Yes.

Sulphuric acid from recovered sulphur, contains no sensible quantity of arsenic.

6507. Recovered sulphur may contain a little arsenic, may it not?—I do not think it is likely when made by the Chance process. It is all made from sulphuretted hydrogen volatilised by means of carbonic acid.

6508. You think that recovered sulphur would not contain any sensible quantity of arsenic?—Not any sensible quantity. The acid from it would be quite as good as if made from brimstone, but it is not brimstone acid for all that.

6509. The introduction of the Glover tower has effected considerable economy in the manufacture of sulphuric acid?—Yes.

6510. It has done that, I presume, by employing the heat of the gases as they come from the kilns in concentrating the oil of vitriol?—That is so.

6511. In order that that heat may be in a maximum quantity it is necessary that these gases must be delivered as promptly as possible from the kiln into the Glover tower?—Yes.

6512. Therefore there is no intermediate cooling process which would allow of the deposition of the arsenious oxide?—No, we always try to make the flue as short as possible.

6513. In the old-fashioned system there was time given for a deposit of the arsenic?—Yes.

6514. In the old-fashioned method of making oil of vitriol there was a less chance of any large quantity of arsenious oxide getting into the oil of vitriol?—Yes; it used to settle in the cooling flue, and was taken out generally twice a year. The plant was stopped for cleaning the long flue out. We used to clean out in one particular flue I remember three or four cart-loads of arsenic at a time.

6515. Therefore the effect of this economy has been to bring about the possibility of a larger introduction of arsenious oxide into the acid?—Yes.

Concentration of arsenic in Glover tower.

6516. But as the method is at present worked, that arsenious oxide is largely concentrated in the Glover tower?—Yes.

6517. These acids of which we read in the newspapers, and which have been connected with the formation of arsenical glucose, were they, in your opinion, probably Glover acids?—They must have been direct from the Glover tower.

6518. And therefore must have contained the maximum possible contents of arsenic?—Yes. I have never seen such samples myself in the whole of my experience.

6519. (*Sir William Church.*) You saw examples of the acid that had been used?—No, but I have seen the results.

6520. You are judging from the analysis?—Yes. I have never seen such results.

6521. Is it common to get actual deposit of arsenic as a sediment from Glover tower acid?—Yes, it is, in the works themselves, but not in customers' tanks outside.

6522. To be sent out?—No.

6523. (*Professor Thorpe.*) If you object to give an answer to this question you will say so; but do you think it would be a proper thing for any oil of vitriol maker to send Glover acids to persons calling themselves sugar refiners?—Not if they knew they were sugar refiners; or for the preparation of food of any kind.

De-arsenicated oil of vitriol suitable for food purposes.

6524. It has been suggested to us that it would be desirable to prescribe that whenever sulphuric acid is used for food purposes it should be brimstone acid; do you think that is necessary?—No, I do not think that is necessary at all.

6525. You believe that the methods of de-arsenicating oil of vitriol are so effective that purified oil of vitriol could be obtained with certainty?—Yes.

THIRTEENTH DAY.

AT WESTMINSTER PALACE HOTEL.

Friday, 3rd May, 1901.

PRESENT:

The Right Hon. LORD KELVIN (in the Chair).

The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Professor THORPE.
Dr. WHITELEGGE.
Mr. COSMO BONSOR.

Dr. BUCHANAN, *Secretary.*

Sir HENRY W. PRIMROSE, K.C.B., C.S.I., called; and Examined.

6525.* (*Chairman.*) You are the Chairman of the Board of Inland Revenue?—Yes.

6526. Your Board possesses considerable powers over breweries?—We do.

6527. These powers have been given in one respect for the protection of the Revenue?—Speaking generally, I think we may say so.

6528. But not merely for the protection of the Revenue?—The powers given us under the Act of 1888 go rather beyond that; otherwise I should say they were confined wholly to the protection of the Revenue.

6529. The Revenue is derived from the sale of certain objects?—That is so.

6530. It might be presumed that the Government in getting Revenue from the sale of objects would itself as far as possible guarantee the healthfulness of those objects by the sale of which it makes money?—I am not quite sure that that has been the view of the Government.

6531. Does it seem to you right that the view of the Government should if necessary be altered so as to adopt that conclusion?—That is a large question of policy. As regards the actual fact I do not myself read the law as implying that hitherto we, as representing the Government, are responsible for the wholesomeness of the taxed article.

6532. There is a Revenue Act, or Acts, which might conceivably be utilised for the protection of public health?—That is so, certainly.

6533. If it could not be conceivably so utilised, would not the Act need amendment?—If it was desired to impose more direct responsibility upon the Department no doubt the law would have to be altered.

6534. But is it not right that the contingency of making money from the public by selling poisons, or injurious ingredients, should be provided against?—I think it may be provided against in another way: by making the persons who sell the article responsible, rather than by making the Government responsible who merely take a tax upon the article.

6535. To secure that no article liable to tax shall pass without taxation it is necessary to analyse some of the products?—Yes.

6536. Ought not the law to be that in analysing those products care is taken—not merely may be taken, but shall be taken—that the products are not injurious? There is an opportunity of testing; in fact, there is an obligation to chemically test the articles on which the tax is leviable?—Yes.

6537. Is it right that the articles should pass through the hands of an analyst of the Revenue and pay tax and yet be poisonous?—The analyses required to test for purposes of health, I take it, is different from the analyses required for the test for the purposes of Revenue. Therefore it would be an additional duty imposed if we had to test for soundness of condition.

6538. Is not that a duty that is owed to the public from whom the money is taken?—I should not like to express an opinion upon that.

6539. The Act is framed so that it can be conceivably utilised for the protection of public health?—Yes. *Sir H. W. Primrose.*

6540. Is it not right that as far as that is conceivable or possible in the Act it ought practically to be done?—I think a great deal would depend upon what was proposed. I should say it would not be of practical advantage to make the Department primarily responsible, because I think it would interfere very seriously with the convenience of the trade. Everything would be sent up to one central laboratory, which would have to be considerably enlarged if they were to analyse very closely and carefully the whole of the produce of the breweries from the point of view of public health, and the analyses would probably be very considerably delayed by them. In the meantime very much of the produce would have gone into consumption, or may have gone into consumption. I should say myself that that is a duty which would be better entrusted to the various localities. The mere fact that the article is taxed ought not necessarily to make any great difference as compared with articles that are not taxed. The locality is responsible for all articles of food and drink that are sold, and I think it would be better to leave to them that responsibility with regard to beer in the same way. Objections to making Board of Inland Revenue primarily responsible for purity of beer.

6541. And not to include any protection of the public against poison in the analyses that are made for protection of the Revenue?—I think it would add very largely to the business of the Central Government Laboratory, and I think it would be a pity to make the Central Government Laboratory primarily responsible for that investigation. I think its proper function is rather that of a court of appeal or referee in disputed cases.

6542. Has in fact the clause in the 1888 Act as to noxious ingredients been acted on?—No, not as regards noxious ingredients; it has been acted upon once as regards a material or substance which was considered to be injurious to the Revenue, namely, saccharine. As soon as the Act was passed a notice was published in the "Gazette" prohibiting the use of saccharin. Perhaps I may hand in a copy of that prohibition. It says that the "use of the said extract or product is calculated to affect prejudicially the interest of the Revenue." And thereupon the use of it was prohibited. That is the only order that has been issued under the Act of 1888; and in no case has any order been issued prohibiting the use of a substance on the ground of its being noxious or deleterious. Under 1888 Act Saccharine prohibited for revenue reasons, but no ingredients on ground of risk to health.

6543. (*Sir William Hart-Dyke.*) As regards health?—Yes.

6544. (*Chairman.*) So that I may take it your answer to the question: Has the clause in 1888 Act as to noxious ingredients been acted upon, is No?—Yes, the answer would be no.

6545. Without reservation?—Yes.

6546. Can you give a synopsis of the powers which are actually possessed under the Act of 1888 and of the powers of the Board of Inland Revenue under any other Acts which may bear on the protection of the

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public health?—I have a note here of those of the powers which might possibly be utilised for the protection of the public health; it by no means includes all our powers, but includes, I believe, all those germane to this Inquiry. Our first Act is the Act of 1880; an Act which substituted a beer duty for the malt duty, 43 and 44 Victoria, Chapter 20. Under that Act every brewer of beer for sale is required to take out a licence and to make entry of his premises, and we have power to visit the premises at any time. Under Section 26 we are empowered to take samples of any worts, beer, or materials for brewing in the possession of the brewer. That is the material provision as regards this Inquiry, that we have power to take sample at any time of practically anything in the brewery. Then we come to an Act of 1885, which amended the Act of 1880 to a certain extent, and that gives us certain powers over the use of sugar by brewers, and it requires that they shall keep a sugar store, and that they are prohibited from receiving sugar unless accompanied by an invoice from the seller containing the particulars thereof. The Commissioners of Inland Revenue are empowered to require by a notice served upon the brewer that an account of all sugar received shall be kept; and upon the notice being made the brewery is required to deliver to the officer of Inland Revenue all the invoices relating to the sugar subsequently received. Perhaps I had better put off until later saying exactly what we have done under these different clauses. I will for the moment merely go through what our powers are. Under another section of that same Act a brewer of beer for sale is prohibited from adulterating beer or adding any matter or thing thereto, except finings for the purpose of clarification, or other matter or things sanctioned by the Commissioners of Inland Revenue. The only other important provision is that in the Act of 1888 to which reference has been already made, and which enables us to prohibit the use in brewing of any substance or liquor of a noxious or detrimental nature, or which, being a chemical or artificial extract or product, may affect prejudicially the interest of the Revenue. That is a short statement, I think, of the powers that might be useful in connection with this Inquiry.

Powers of Excise at brewery.

6547. The sampling and examination of materials in works is permitted?—Yes.

6548. Is it practised as a rule or only in cases of appeal?—That is practised regularly. I think I may say there are two main objects; one is to check the brewing value of materials, especially of any new materials. Supposing any new material is introduced as a material for brewing, we should have to estimate its value for brewing purposes, and assign it a value relatively to malt—malt on one side or sugar on the other.

Object of sampling by Excise Officers.

6549. (*Mr. Cosmo Bonsor.*) As regards its product?—Yes.

6550. (*Chairman.*) That is done regularly in every brewery?—That would not be done merely for the purpose of checking brewing materials but only when there was some special reason. That perhaps would come under the second object for which we take samples of materials and wort, viz., to check the returns of the brewers and of our own officers of the results of the brewing. Where there is any suspicion as to the correctness of such returns samples of materials and wort would be specially taken. For instance, if we found that the produce of a brewery was habitually less or more than what would have been expected from the materials entered, because I may mention that the brewer before he begins to brew has to enter the whole of the materials that he proposes to use in that brewing—although we do not charge on that we use that as a means of testing the correctness of the results of the brewing on which we do make the charge—if it were found that the results of brewings were suspiciously large or suspiciously small, then we should take special samples. Otherwise we merely follow a prescribed course. Our officers are told to take samples at certain stated intervals, not regularly, but from time to time, and to send them up to the laboratory for testing. There is another occasion upon which samples must be taken of the wort, and that is, if before our officer has taken an account of the wort the fermentation has begun, then a sample is taken in order to determine what the original gravity was, because the gravity would have changed owing to fermentation having begun. Speaking quite generally, the principal object I should say of taking samples is to check the returns made by the brewers and by our own officers upon which the duty is assessed.

System of sampling.

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6551. And that is done practically from day to day, even when no question arises?—Yes, that is being constantly done.

6552. With regard to the receipt and storage of sugar, by sugar is meant what?—Sugar and all its equivalents, legally everything that is not malt and corn is sugar.

Knowledge by Excise "sugar" stored at brewery.

6553. Cane sugar, if it was in the brewery, would be included?—Yes.

6554. Glucose would be included?—Yes.

6555. And inverts?—Yes. Under Section 7 of the Act of 1885 we have very considerable powers, but as a matter of fact we have not found it necessary to enforce them in all respects. We practically content ourselves as regards sugar with requiring that brewers should keep any sugar that they have in sugar store. It is not to be in any other part of the brewery. There have been one or two occasions upon which we have served the notice upon the brewer to deliver his invoices, but none of recent years, and I think only two or three times since the Act was passed. It is only where we have not been satisfied with the condition of things, and where there has been some suspicion that a brewer has been using sugar improperly. As regards adulteration or additions to beer, I may perhaps point out that that refers to finished beer. In the manufacture of the beer the law practically permits the use of any material capable of being used in brewing. All that we have to do is to value the material relatively to malt or sugar. The Act was passed in 1885, I believe, because it was found that we required greater powers in order to prevent the addition of sugar or sugar solutions to beer after it was finished.

Adulterations of finished b

6556. That is what is called priming?—Yes, in order to regulate that. Our policy has been not to object to additions that do not affect the gravity of the beer, or the apparent gravity of the beer. Provided the substances that have been submitted to us do not appear to alter the gravity of the beer after it is finished, or to alter the apparent gravity of the beer, we should not object to them provided they were wholesome. If there was anything submitted to us that was obviously unwholesome we should object to that, but in no instance has any substance been submitted to us for addition to beer that we had to object to on the ground of its being unwholesome. Additions are made for three purposes. First, for fining or clarifying the beer, for that isinglass or some other similar substance is commonly used. Then there is the priming, which is intended to give a certain life and briskness to the beer before it goes out. Mainly sugar solution is used for that, if not entirely. We have had one or two instances of things in the way of frothing powders to give a head to beer, but most of those have been refused. I believe Bradley's powder is allowed, otherwise we have refused several.

What is r garded as such by Excise Authoriti

6557. Refused on what ground?—For instance, last year we had a case before us of some stuff called stoutine. That was intended to give a head to beer, but in the advertisement it also claimed that it practically enabled the brewer to diminish his gravity by four degrees.

6558. What does that mean in relation to alcoholic strength?—That would not necessarily affect the alcoholic strength, but it would affect the amount of duty chargeable.

6559. The duty is charged according to the gravity?—The original gravity of the worts before fermentation.

6560. Is there any taking of specific gravity of the finished beer?—No, unless in the case of any suspicion that the gravity has been increased. Supposing sugar were added after we had taken the gravity, and the dip of wort, then we might test the finished beer, but in the ordinary course of things we merely test the original gravity of the wort before fermentation, and assess the duty on that, and do not again test the beer.

6561. Adding sugar as priming would add to the specific gravity of the finished beer?—Yes, to a small degree, and of course duty is charged upon so much sugar as they put into the priming.

Duty charged priming

6562. Duty is charged on the priming?—Yes.

6563. Is the charge on the same principle as if the priming ultimately became fermented?—It is charged on the same principle as if it had been put into the original wort.

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6564. So that priming is charged as a fermentable material?—Yes.

6565. And it does add to the alcoholic strength after the beer has been kept for a little time?—I suppose it would very slightly.

6566. It gives some degree of briskness to the beer, and in so doing must add to the alcohol?—Yes.

6567. (*Professor Thorpe.*) That is indicated by a term frequently used here, "the after-fermentation." There is always an after-fermentation, and that of course acts upon the added sugar?—Yes.

6568. (*Chairman.*) Would you kindly give us the titles and dates of the Acts?—The Act of 1880 is the Act 43 and 44 Victoria, Chapter 20; 48 and 49 is 1885; 51 and 52 is 1888. Just to finish on that point of the additions to beer, there is one other object in the additions, and that is what they call preservatives. Certain things have been sanctioned for that purpose, such as bisulphate of lime, sulphate of lime, salicylic acid, and carbonate of potash. I think that represents practically the whole of them.

6569. I suppose the effect of these substances is to keep the beer from going sour?—Yes.

Salicylic acid in beer.

6570. Is salicylic acid admitted to be useful in that respect?—I believe brewers consider it is so. I am not competent to speak on that, I am not a chemist.

6571. Is that prohibited?—No, it is allowed.

6572. The question of the health of the drinker of the beer in respect of salicylic acid has not appeared?—No.

6573. None of the other substances that you mentioned are considered as adulterations?—No, because they have been allowed by the Commissioners of Inland Revenue.

6574. What is adulteration in the sense in which the word is used in the Act?—I suppose any addition really would be adulteration, but it ceases to be adulteration if the substance added is approved by the Commissioners. That I take to be the state of the law.

6575. We were told by one of the public analysts who gave evidence that he would consider glucose as an adulteration in golden syrup. That does not come under the Inland Revenue, I presume?—No.

6576. The question what was adulteration and what defines adulteration necessarily arises when you meet with the word in the Act?—We should consider the addition of water, for instance, an adulteration. It is dilution, but I think it might fall within the legal meaning of adulteration.

6577. The addition of water to whisky by a publican, is that adulteration of the whisky?—I think that might perhaps be adulteration within the meaning of the section.

6578. And the publican would be liable to be fined for getting money under false pretences?—A publican is prohibited under the Sale of Food and Drugs Act from selling whisky below a certain strength, or any spirit. Whisky 25 per cent. under proof is the minimum at which a publican may sell. He could put water to that extent.

6579. But if he puts in more water he is cheating?—He could be prosecuted under the Sale of Food and Drugs Act.

6580. But not in virtue of the adulteration being deleterious to health?—No, as being a fraud upon the purchaser.

6581. Not letting the buyer have his money's worth?—Yes.

6582. (*Professor Thorpe.*) I think also it is not in that case the Revenue who prosecutes him, but the public authority?—It is. We have never taken action I am told on Revenue ground.

6583. (*Chairman.*) With regard to the prohibition of substances under the Act of 1888, that is for two purposes; (1) to secure the Revenue, and (2) to protect the public against noxious ingredients?—Yes.

6584. Can you suggest any really practical method of utilising that provision of the Act of 1888 so far as public health is concerned? Other authorities must be responsible also, but can you suggest any useful mode of taking advantage of that provision of the Act by the Board of Inland Revenue?—We considered carefully whether in connection with this particular epidemic and this particular incident of the arsenical poisoning of beer we could usefully exercise the powers that are given us by the Act of 1888, and we came, on the whole, to the conclusion that it would be extremely difficult. In the first place, the substances that have produced the epidemic were not noxious or detrimental in their own nature. It was owing to the accidental introduction into them of a deleterious substance.

Reasons for not prohibiting arsenical sugars under 1888 Act.

6585. But one of the substances was arsenic?—That is so; and, of course, we could prohibit the use of arsenic. But it would be almost absurd to prohibit the use of arsenic. The question is, could we have prohibited the use of glucose or invert sugar containing arsenic? That was the point we considered. As a matter of law we are advised that it would be conceivably possible, but as a matter of practice it seemed to us that it would be very difficult to enforce the prohibition, for the reason that no Excise officers could possibly state whether or not the article was or was not contaminated with arsenic. It would have involved sampling every consignment of invert sugar or glucose that was received at a brewery, sending it up to London to be tested, and then reporting whether it was free or not. To be of practical use it would have been desirable that a brewer should not have been allowed to use it until it had been certified as free, and we came to the conclusion that that section would not really meet this particular case. A suggestion was made which I think is a practical one and might be useful, and in which we could very well assist, that the law should provide that no brewer should receive into his brewery any of the substances without a certificate that they had been submitted to a particular test, the test being one that should be prescribed by a suitable authority, either by the Government Laboratory or other authority, and that then we could aid in seeing that that provision of the law was enforced. Under this power we have in the Act of 1885, we could see the invoices and certificates and occasionally test the samples to see that the certificates were really valid.

6586. But suppose you put the question of deleteriousness to health practically on the same footing as the question of the revenue. Of course, it would be impossible to send samples of every consignment to the London Central Laboratory as you have explained, but that is not done either for the protection of revenue. You do not send samples of every substance to the Government Laboratory in London for the sake of protecting the revenue, but it is only in a case where your inspectors are not satisfied, and think that some of the substances used must be tested?—Yes. A certain number are dealt with at local laboratories, but the majority are sent to London. We deal with some samples at the local chemical stations, but we have not a great many of them, and the majority are sent to London. My point is that if we were testing in matters of health it would mean a far larger number of samples than are necessary for the purpose of revenue. It would never be safe for us to assume that things were going right.

6587. A small proportion of all the material comes to London and is tested for the sake of the revenue?—Yes.

6588. But not hitherto for the protection against deleterious ingredients?—No.

6589. Would there be any real difficulty in ordering that every sample that is sent for test to the Central Laboratory in respect to duty should also be tested in respect to healthiness. That would add somewhat to the work of the laboratory, but it would not be an enormous expense to test specimens that you have already in hand and are testing partially, simply making the test somewhat more comprehensive and including a test against arsenic, which we now know to be a substance that beer is liable to contain?—If it was limited to testing for one particular poison like arsenic I imagine that would not very seriously affect us. But then comes the question, can you limit it to one thing? Nobody suspected the presence of arsenic a year ago, and a year hence something else may be found.

6590. Of course it would be impossible to exact a full chemical analysis of every product, but it would not add greatly to the labour at present incurred to test for a substance we now know to have entered considerably and injuriously into the beer on which the duty is paid?—I am not really qualified to speak on that, and I should suggest that the Commission might perhaps take evidence on that from Dr. Thorpe, the Principal of the Laboratory. He could tell you at once.

6591. We hope to do that and have his advice upon the matter, but in the meantime we may take it you do not see any constitutional or legal difficulty in extend-

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6656. I suppose some of the samples of beer were found to contain arsenic?—Nearly all of those that were submitted for destruction. There were cases, or certainly one case, in which a considerable quantity of beer was destroyed, and we did not discover any arsenic in it. Their chemist had discovered arsenic, but the Government laboratory did not.

Only beers on which rebate claimed were tested.

6657. Where arsenic was found in a large quantity, were the local authorities informed?—No; because, as I explained, the examination that we made was in respect to the beers which were condemned by the brewers themselves.

6658. (*Professor Thorpe.*) They were all beers lodged for rebate in consequence of containing arsenic, or of being brewed from materials which were known to contain arsenic?—Yes.

6659. (*Dr. Whitelegge.*) The enquiry did not proceed beyond samples taken from breweries by reason of being known to contain arsenic, and proposed for destruction and rebate?—Yes.

6660. You mentioned the circular issued by the Local Government Board to the local authorities?—Yes.

6661. That was issued by the Local Government Board on the advice of the Board of Inland Revenue?—No; I should not like to say that.

6662. At all events, it was issued by the Local Government Board?—Yes.

6663. Has the Board of Inland Revenue ever issued any instructions in connection with the arsenic in beer?—No.

6664. You suggested, I think, that the local authorities ought to be primarily responsible for dealing with the sources of danger to public health?—Yes.

6665. You are thinking of the finished beer?—Yes.

6666. And the finished beer in the hands of the retailers?—Yes.

Local authorities might be given powers to take samples at breweries.

6667. Were you contemplating further powers for the local authorities to deal with the beer before it reaches the retailers?—I see no reason why they should not be allowed to have samples at any stage of manufacture.

6668. Irrespective of locality?—Yes; within their own area. The local authority should have power, if it was thought necessary, to watch over the manufacture of beer, as well as over the distribution of it.

6669. You are aware, of course, that no such power exists now?—I know.

6670. Would you extend that suggestion to the manufacture of beer ingredients?—That is a point I do not feel I am competent to speak about. It is quite conceivable that it might be a desirable thing to do.

6671. You suggested further that the brewer should be required to obtain a certificate of purity of the ingredients, as a measure of protection?—I think that would be a good thing.

6672. What would happen if such a certificate were given inaccurately? What machinery would there be for enforcing the accuracy of such a certificate?—None, as things are now. I am contemplating legislation.

Inaccurate guarantee of purity of brewing ingredients should involve penalty.

6673. But assuming there was legislation requiring a certificate, and, as you further suggest, a certificate in prescribed terms, have you thought what machinery ought to be brought into operation, assuming an inaccurate certificate to be given?—I assume that penalties would be imposed. We did sketch out the sort of provisions that might be put into the law. No doubt there would have to be heavy penalties attached to the giver of the certificate.

6674. I understood you to say it would not be convenient, at all events to the Board of Inland Revenue, to undertake any extensive duty of analysis of samples, and I think you further told us that the brewer ought not to be compelled to make analysis. The local authorities, as the matter stands at present, would not be on the brewers' premises, and some sort of provision would seem to be necessary for action in case of the certificate being wrong?—No doubt. What might be done, and I think perhaps would not be a bad thing to do, would be at the same time to give powers of inspection of the manufactories where these glucoses and so on are made. There are not a great many of them. They would be the people who give the certificate, and therefore it might be well to place them under some sort of observation, giving power to enter their premises.

6675. If the local authorities had power to enter on the brewers' premises, would they not have the great advantage which at present the Board of Inland Revenue officers have, and the local authority's officers have not, of testing from a large bulk?—Yes.

6676. If samples are taken from the brewery, is there not the great advantage that the samples can be taken from a large bulk?—Yes.

Whether control of brewing ingredients should be local authorities Board of Inland Revenue.

6677. As matters stand, and without the local authority having power of entry to the brewery, or manufactory, are we not placed at a great disadvantage, first by not being able to test in bulk, and secondly, in the case of beer, by the very large bulk of the individual sample they have to take from the retailer?—No doubt that would be so.

6678. You said it would be a very difficult task for the Board of Inland Revenue to undertake extensive sampling for the protection of public health, but it would be possible if their duty were limited to one item such as arsenic?—Yes.

6679. Of course the same difficulty of volume of work would apply equally if that were done by the local authorities?—No doubt.

6680. What is attempted under the Sale of Food and Drugs Act is not to cover the whole ground, but to test by infrequent sampling, probably not one in a thousand of any given food substances?—That is so.

6681. So that as matters stand, if it is difficult for the Board of Inland Revenue to contemplate an extensive sampling of ingredients in bulk or food in bulk, it is almost impossible for the local authorities?—I think it would be much less difficult for the local authority. They would only have to deal with the breweries within their own area, and they would not have to deal with such an immense number of samples as we should have.

6682. You mention certain substances as having been approved by the Board of Inland Revenue, and certain others having been observed. I did not quite understand your answer to the Chairman to be final as to the consideration of health in that approval or refusal. Have considerations of health entered into the decision?—Yes, to this extent, that if any of those substances had been thought to be dangerous to health in the quantities that they would be used, we could have refused. That I have no doubt about.

Additions injurious substances finished b would be objected by Board Inland Revenue.

6683. Under the powers of the Act of 1888?—No; rather under the Act of 1885, because these are things that are added. They come under this: "The brewer is prohibited from adding any matter or thing to beer except finings for the purpose of clarification or other matters or things sanctioned by the Commissioners of the Inland Revenue." When they want to add to finished beer something for the purpose of priming or preserving, they have to submit the substances they propose to use to us, to know if we should object. We should object strongly, I think, to anything which could be regarded as undoubtedly dangerous to health.

6684. Then the fact that you do take public health considerations into account in a decision under that head does not depend in any way on the reading of this doubtful point in the 1888 Act?—No; that is quite independent of the 1888 Act.

6685. Has your view of the 1888 Act in that respect always been the same?—Always.

6686. I think you were a member of the Committee on Beer Materials?—I was.

Beer Materials Committe on control Board of land Revenue.

6687. In the report of the Committee there is one paragraph: "Moreover the Treasury are empowered to prohibit the use in the manufacture of beer of any substances or liquor of a noxious or detrimental nature. It is the duty of the chemist employed in the Government laboratory to keep a vigilant watch in this respect over all beer brewed and sold, and they have ample opportunities for so doing; but it has never in practice been found necessary for them to prohibit the use of any material by reason of its detrimental nature, the prohibition of saccharine in 1886 having been due solely to reasons affecting revenue." In that paragraph are we to understand that the "noxious or detrimental" are held to apply mainly to revenue considerations?—I think not. I think the intention was to indicate that if in the course of their examination of material the Board of Inland Revenue had come across things clearly noxious or detrimental in their nature, they had opportunities of observing them, and could have prohibited them. I think it is intended to reassure the public mind as to their not being noxious or detrimental substances used.

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6688. Although an examination has been made, none have ever been found?—Yes.

6689. I see Mr. Bannister, in his report to that Committee, says:—"The samples of beer and wort that came to us were not examined except for the original gravity. The samples of beer and wort that came up to us are divided into two classes, some for the determination of original gravity just for the purpose of checking brewers' returns, but others are actually examined for the purpose of seeing whether they contain any deleterious ingredient. That work is constantly going on." That would apply, then, to the wholesomeness and absence of poisonous ingredients?—Yes. I do not understand in our laboratory that we have made exhaustive analyses with the view of looking for such a thing as arsenic, for instance. I am not a chemist myself, but I understand in analysing you do not find a thing unless you look for it, and I do not believe the laboratory has assiduously looked for such elements as arsenic. But if there had been anything very serious there would be an opportunity to find it. I think that is all Mr. Bannister meant.

6690. Having found that arsenic was present in beer, and in the glucose from which some of that beer was made, the difficulty that the Board of Inland Revenue felt was that the arsenic was not a substance added as such, but was merely an ingredient of the beer ingredient?—It was a pure accident. In speaking as regards our action last December and January, we know a great deal more about the thing now than we did then. Even then it appeared more or less an accident. We knew it was not distributed over the whole country, but limited to a certain part of the country, and now it appears it was limited to the product of one factory.

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6691. (*Professor Thorpe.*) I think I should like to bring out one or two points which I daresay Sir Henry Primrose would wish to make clear to the Commission. You told us that you thought it was no necessary duty of the Excise authorities, because they took a tax off what was a food or drink, that they should necessarily be responsible for its quality or purity?—That is my view.

6692. There is no logical necessity imposed upon it by virtue of that accident?—No.

6693. It is a fact, is it not, that the Excise takes a revenue off a number of proprietary articles, as they are called?—Yes; patent medicines.

6694. But it undertakes no responsibility as to the character of those things?—Certainly not.

6695. The Revenue authorities, speaking generally, do handle, for fiscal purposes, considerable quantities of food, the Customs for example?—Yes.

6696. They take duty off such things as dried fruits, chocolate, liqueurs, wines, but in levying the duty on those things they are not in any way answerable, nor do they take any responsibility for their quality?—That is so.

6697. (*Dr. Whitelegge.*) Nor, I presume, is there any paragraph like this we have been discussing in the 1888 Act, applicable to patent medicines or other substances?—The 1888 Act would apply to the patent medicines. It does not specially mention beer. What it really says is, "on any article liable to a duty of Excise," therefore it would include the patent medicines.

Sir H. W. Primrose.

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6698. (*Professor Thorpe.*) But with respect to the intention of the 1888 Act, the difficulty we had in considering the application of it, I believe, must be that the substance which was to be prohibited was in its very essence and in its very nature detrimental—that it was not accidental detrimental contamination, but it was like coculus indicus, or grains of paradise, or quassia, that is things which were of their essence and nature detrimental?—That is the view which has always been acted upon, and held at Somerset House.

Question of rebate on unsound beer.

6699. With respect to the question which Mr. Cosmo Bonsor put to you, as to the willingness of the Excise authorities to consider favourably an application for the return from the publican of the spoilt beer or from the traders, there is in the Customs procedure a somewhat analogous case as regards tobacco which is not marketable—offal tobacco, for example?—Yes.

6700. There the Customs will receive and repay the duty on that on the ground that it is not of any commercial importance?—Yes.

6701. And this idea that possibly the Excise might do something similar in the case of unusable beer?—Yes, that is a very parallel case.

6702. In the answer you gave to Dr. Whitelegge respecting the action which we might take in superintending, or even that the local authorities might take in superintending, the output of the glucose and invert works, there would be a difficulty, would there not, that a considerable quantity of similar material is imported?—Yes.

6703. Therefore the character of that material could only be guaranteed on the certificate?—That is so.

Manufacture of imported glucose cannot be supervised.

6704. In the case of imported glucose, the local authority or the Excise would have no means whatever of controlling the manufacture of these things?—No, that would have to be done on the certificate.

6705. It would rather lead to complications to have two methods of supervising the genuineness or character of the same product?—Yes; I think it would.

6706. (*Sir William Hart Dyke.*) With regard to administration, may we gather that with regard to guaranteeing the public against a catastrophe such as lately happened, you could easily collect certificates of purity, if such were demanded? It would not bring any extra stress of work on your department to do that?—No, I think it would be quite simple.

6707. But if we endeavoured to press you further, and if the guarantee of purity by test is to be demanded of each ingredient entering the brewery, to place this on your Department would be beyond the scope of your duties, and cause a dislocation of the work of your Department?—That is my view.

Primary responsibility for purity of beer and food should rest with Local Government Board.

6708. And, therefore, whether Parliamentary action be thought necessary or not, in any case you think the onus of protecting the public in future should be thrown on the Local Government Board?—I think that would be consistent. They are already responsible for non-exciseable food and drinks, and I do not see why there should be any great difference made as regards the exciseable.

J. C. own.

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Dr. James Campbell Brown, called; and Examined.

Dr. J. C. Brown.

6709. (*Chairman.*) You are Professor of Chemistry in University College, Liverpool, and Victoria University, a d Head of the County and City Laboratory, Liverpool, and, in the first place, you have some results of analysis of various substances for arsenic to give us?—Yes.

The following statistics cover a period of two months from the 26*th November*, 1900, *to* 31*st January*, 1901. They include samples received from inspectors from the Administrative County of Lancaster, the City of Liverpool, and the Boroughs of Bootle, Blackburn, Blackpool, Barrow, and Preston:—

Beer, 890 *Samples.*

1	contained	1·5	grain of	white	arsenic	per gallon.
1	,,	1·35	,,	,,	,,	,,
1	,,	·8	,,	,,	,,	,,
4	,,	·75	,,	,,	,,	,,
3	,,	·66	,,	,,	,,	,,
1	,,	·6	,,	,,	,,	,,
4	contained	·5	grain of	white	arsenic	per gallon
1	,,	·3	,,	,,	,,	,,
1	,,	·28	,,	,,	,,	,,
2	,,	·25	,,	,,	,,	,,
4	,,	·2	,,	,,	,,	,,
4	,,	·16	,,	,,	,,	,,
9	,,	·14	,,	,,	,,	,,
5	,,	·11	,,	,,	,,	,,
3	,,	·1	,,	,,	,,	,,
5	,,	·07 to ·084	,,	,,	,,	,,
2	,,	·03 to ·06	,,	,,	,,	,,

1 sample made from malt dried with best anthracite and afterwards once cleaned, contained ·014 grain, was the largest quantity passed on the preliminary qualitative analysis.

52 accurately determined.

Dr. J. C. Brown, 3 May 1901.

Add to these :—

16 additional samples approximately estimated to contain between one-half grain and one grain per gallon.

33 additional samples approximately estimated to contain between one-fifth to one-half grain per gallon.

33 additional samples approximately estimated to contain between one-tenth to one-fifth grain per gallon.

26 additional samples approximately estimated to contain between one-twentieth to one-tenth grain per gallon

21 distinct traces, but under one-twentieth grain per gallon.

116 detectable but negligible traces.

593 none detectable in half-a-pint.

Total 890 samples of beer.

The larger quantities were all before 6th December.)

During February 1901, a total of 133 additional samples of beer were analysed : —

7 contained about one-tenth grain per gallon, or more than one-twentieth grain per gallon.

14 contained very distinct traces of arsenic.

[All the above 21 samples were from the County area.]

112 contained such very minute traces that they were considered genuine. Of these genuine samples

68 were from County area.

34 „ „ City of Liverpool.

10 „ „ small Boroughs.

112

in brewing sugars.

Samples of brewing and other sugars from various sources.

Brewing sugars :—

1 black glucose contained above ·131% = over 9 grains per lb.

1 glucose contained ·115 % arsenic = 8· grs. per lb.

1 „ ·096 „ „ 6·72 „

3 (1 glucose, 2 inverts) contained ·062 % arsenic = 4·34 grs. per lb.

1 glucose contained ·037 % arsenic = 2·6 grs. per lb.

1 „ „ ·031 „ „ 2·17 „

1 „ „ ·028 „ „ 2·

2 „ „ ·027 „ „ 1·9 „

1 „ „ ·025 „ .. 1·75 „

1 „ „ ·022 „ „ 1·54 „

2 „ „ ·019 „ „ 1·33 „

2 „ „ ·018 „ „ 1·25 „

3 „ „ from ·015 to ·01 % arsenic = 1 to ·75 grs. per lb.

1 „ „ ·008 % arsenic = ·5 grs. per lb.

1 (not Bostock's) contained ·004 % arsenic = ·28 grs. per lb.

1 glucose contained ·003 % arsenic = ·2 grs per lb.

2 (not Bostock's) contained ·0025 % arsenic = ·175 grs. per lb.

25 in all.

37 others contained a serious quantity of arsenic, but the quantities were not determined.

2 others contained minute traces.

Total 64 contained arsenic.

70 „ none.

„ 134 analysed.

Other saccharine substances :—

195 samples of Jam, Sweetmeats, Syrup, Cane Sugar, &c. } During 3 months, 1 December 1900 to 1 March 1901.

From the County		86
„ „ City		75
„ Blackburn		5
„ Blackpool		13
„ Barrow		8
„ Bootle		8
		195

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Malt.

in malt, Forty-eight samples of malt from private sources have been analysed during three months. All except six contained arsenic in quantities varying from a minute trace up to a quarter of a grain per lb.

The six samples of malt free from arsenic had all been brushed after they came from the kiln.

Six additional samples of malt have been analysed in March. These show a great improvement. The largest quantity is ·04, or 1·25th grain per lb., and two contain only the minutest trace—practically nothing.

Yeast.

in yeast, Nineteen samples of yeast were analysed, all of which (except one) contained a distinct trace of arsenic. The quantity in each was too small to be determined, but the average quantity in the 18 samples was found to be ·015, or 1·67th grain per lb. They included British and foreign pressed yeast and balm from a brewery.

Latterly 14 additional samples of yeast have been analysed, all of which except two contained similar quantities of arsenic.

Sulphuric Acid.

in Nicholson sulphuric acid. I have analysed six samples of brown oil of vitriol obtained from Messrs. Bostocks.

The first is most instructive, received on 27th November, 1900. When received it was clear and brown, but it was supersaturated with arsenic. It contained 2·6 per cent. of arsenious oxide. On standing in a cool place for some weeks, with occasional disturbance, it gradually deposited crystals on the sides and bottom of the bottle, and when the clear decanted acid was analysed on the 17th January, 1901, it contained only 1·12 per cent. arsenious oxide, the rest having been deposited in the form of prisms, presumably rhombic. When these crystals were placed under the microscope, moist with oil of vitriol as they were, and a drop of water was added to dilute the oil of vitriol, the crystals cleaved into octohedra with flat sides, while some dissolved in the hot acid. On leaving the crystals in the liquid they gradually grew, especially on the flat sides, and in two hours they were large and perfect octohedra.

Photographs show the three stages, though much less perfectly than they were seen under the microscope.

Other samples analysed in 1901 contained :—

1·92 per cent. of arsenic, including crystals deposited.

2·36 per cent. „ „ „ „

2·24 per cent. „ „ „ „

2·5 per cent. „ „ „ „

per cent., of which 1·9 was in the clear acid and deposited.

The arsenic in each case was purified and weighed precisely, and the quantity of arsenious sulphide weighed from 11·32 grammes of acid has been dissolved and re-precipitated and preserved in a bottle for exhibition.

Selenium Nicholson acid. All selenium was removed, as well as other impurities, before weighing the arsenic.

Every sample of acid contained selenium, but only in very small quantities. The average was probably about ·005 per cent.

One sample contained a quantity which when weighed was ·0046 per cent., another ·0044 per cent., and others smaller quantities.

If the selenium was present as selenious acid about 22lb. selenium or 40lb. selenious acid must have been delivered to Bostock's from 1st April to the end of October.

Selenium occurs in vitriol chambers chiefly as element reduced by the sulphurous acid of the flues, and Glover towers. The small quantity dissolved in the vitriol is probably selenious acid, and it is removed by the same process which removes arsenic industrially.

Beer made from partly-cleaned malt contained 1-30th grain arsenic per gallon.

6710. You have also some general observations on arsenic in beer?—The City of Liverpool was completely cleared of beer made from Bostock's sugar before 18th December, and in the County of Lancaster only a few samples here and there were found after that date. But still arsenic did not disappear from the beer sold even by perfectly reliable houses, whose beer was made from no other materials than malt and hops. It became necessary to trace the source of these smaller quantities of arsenic. The barrels, vats, pipes, and other plant of the breweries had been cleaned, and were found to be quite free from arsenic. Hops and finings and other incidental materials were found to be free from arsenic. Yeast was found to be always very slightly arsenical. In some instances yeast was obtained specially from a very large brewer in the Midlands brewing solely from malt and hops, and still the beer made with it was arsenical. A sample of that yeast was found to be as highly arsenical as Liverpool yeast which had been in contact with some of Bostock's sugar. Beer from the brewery before being fined, and before the last proportion of hops was added, was found to be more arsenical than the finished beer. This is usually the case when the quantity of arsenic is small, but yeast and hops do not appreciably purify more highly arsenical beer. Very large quantities of arsenic break down the yeast cells. In slight cases the yeast and the hop residues from which the beer was drained off were found to contain some arsenic, even when the finished clarified beer, as sold, contained practically none. Hops were found to be free from arsenic, the exceedingly minute trace suspected in one case being too small to be identified. The arsenic was in all cases investigated clearly traced to the malt. The malt used was found to contain more arsenic than the finished beer made from it. A sample of beer made from good malt which had been dried with the best fuel was found to contain as much as 1-12th grain of arsenic per gallon before racking. This whole brew was destroyed. Another sample was made from very similar malt, but not analysed until it was ready for sale, and it contained only 1-70th grain per gallon.

Origin of Arsenic in Malt.—Barley for malting was obtained from the ship and from the quay, and from the storehouse before malting, and was found to be free. Malt from Scotch barley, English, Asia Minor, North and South America, and other places always contained arsenic. This arsenic was traced to the fuel.

The quantity of arsenic in malt from good fuel was usually 1-15th grain per lb.

The best quality of malt was dried with the best fuel, as follows:—

Anthracite which contained only	·0075	arsenic per cent.
Coke which contained only	·0035	„ „
and	·0025	„ „

But this was a very exceptional quality of oven coke, limited in quantity, and it is probable that not very much malt is prepared with such pure fuel as this. Some of the malt dried with this fuel was found to contain ·084, or 1-12th grain of arsenic per lb. The same malt after cleaning (brushing and screening) contained only ·0126, or 1-80th grain per lb.

Other samples were found to contain less arsenic after screening than before, but not so small a quantity as should be; after a single brushing they contained only a distinst trace, while after three brushings the arsenic was almost a vanishing quantity, although arsenic could still be identified from 1lb. of malt.

Malt Dust.—All the samples of dust from the malt screens contained a quantity of arsenic.

Washings of Malt.—Malt, when washed, yielded at once practically all its arsenic to the washing water. The method is not available, however, for cleaning.

Recent Improvements in some Malts.—In the present year, after maltsters had been warned to brush their malt, figures which were obtained from malt as sold were:—

·056, or 1-18th grain per lb., and
·045, equal to 1-22nd grain per lb.

After brushing this was greatly reduced; after triple brushing the quantity could not be estimated. It is probable that most of the beer against which prosecutions have been instituted in the County area since the middle of January have been cases of beer contaminated by malt.

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Instances of Particularly Arsenical Malt.—The following figures have been obtained by precise determination in the case of malt dried with inferior fuel:—

1 sample of malt gave	1·9th	grain	arsenic	per	lb.
1	„	„	„	1·7th	„	„	„
1	„	„	„	1·6th	„	„	„
1	„	„	„	1·6th	„	„	„
1 contained as much as	1·4th	„	„	„

Beer which we are credibly informed was made from some of the above arsenical malts contained 1·5th grain of arsenic per gallon, a serious quantity. I understand the beer was destroyed.

Screening without brushing is not sufficient to remove all the arsenic, because it adheres to the skin of the malt.

But more perfect brushing would undoubtedly remove all but a negligible quantity.

After one brushing some of the above malts came down to 1·25th grain per lb.

6711. (*Professor Thorpe.*) You have had the opportunity of analysing a considerable number of samples of brown oil of vitriol which you obtained from Messrs. Bostock and which you have reason to suppose were of Messrs. Nicholson's manufacture?—I do not know of whose manufacture except from the evidence that was given at the inquests. At the inquests I heard it given in evidence that it was of Nicholson's manufacture, but that all came from Bostock's. *His Nicholson acid samples came from Bostock's.*

6712. How did you obtain them?—Generally the medical officer of health sent one of his subordinates for them to Messrs. Bostock; one was given to me by Messrs. Bostock themselves.

6713. By what authority did the medical officer of health get into Messrs. Bostock's factory and take the samples?—By Dr. Hope's authority.

6714. Is there any statutory power vested in Dr. Hope?—No, he had no power to go if they had refused to admit him. But they did not; they were perfectly willing to give any facility.

6715. It was simply an act of grace on their part that you got samples through Dr. Hope?—Entirely, except in one instance, and in one instance it was by the permission of the official liquidator. That was the last sample I got.

6716. You give the details of the analysis of the oil of vitriol that you made; speaking generally they were practically saturated solutions of arsenious acid in oil of vitriol?—They were all super-saturated solutions. There was more arsenic than the sulphuric acid could hold permanently. When the arsenic was first dissolved it was in warm acid, which can hold a larger quantity, but some time after I got it, almost immediately after, it began to deposit solid arsenious oxide on the sides and bottom of the bottle, and that process of approaching to equilibrium went on for many months. I do not think all the arsenic that should come out in solid is out yet. It is gradually being produced. Here is a portion of the acid. (*Sample put in.*) When that stands a little the acid will be clear and brown. That was quite clear when I got it. *Super-saturated with arsenic.*

6717-8. (*Chairman.*) Was the brown oil of vitriol supposed to be intended for use in making glucose?—It was actually used for making glucose.

6719. I thought they always had it clear?—It is not necessary to be clear. There is no harm in it being brown provided there is no arsenic in it. There may be arsenic in it while it is clear, and there may be no arsenic although it is brown.

6720. But it is much less guaranteeable being pure if it is brown than if it is clear as water?—I think no more nor less guarantee whatever. *Colour of acid no relation to arsenic.*

6721. There is more guarantee if it is clear than if it is brown?—I think not.

6722. We were told by one witness that sulphuric acid ought to be clear as it was a great addition to the guarantee against impurities?—There is a fallacy in that which I will point out. What he no doubt meant was that if the acid has been purified by various processes so as to take out the arsenic, then it will be

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clearer, and that is true; but it may be made clear without any arsenic being removed, so that the mere clearness is no guarantee whatever.

6723. And the brown colouring matter of the brown oil of vitriol may be quite innocuous?—Certainly. Brown oil of vitriol of the old kind made from Sicilian sulphur contains practically no arsenic.

6724. And what is the material that gives it the brown colour?—Traces of organic matter; dust from the air, coal smoke in the process of burning, straw—anything.

6725. (*Professor Thorpe.*) A very small quantity of organic matter will serve to tinge the oil of vitriol and make it very brown?—Very small indeed, a minute particle of sugar will tinge a whole Winchester of acid.

6726. Does your knowledge of sulphuric acid manufacture enable you to give the Commission any information as to the probable origin of this sulphuric acid?—Yes.

6727. From what particular part of the manufacture has the sulphuric acid been probably derived?—I have not the slightest doubt that it was Glover tower acid.

6728. Why do you say you have no doubt it was Glover tower acid?—Because I do not know anywhere else it could get such a quantity of arsenious acid in it.

6729 (*Chairman.*) What are we to understand is the substance which makes this as thick as mud and with a large deposit?—Crystals of arsenious oxide.

6730. This has come from the acid by simply leaving it to itself?—Yes, and it has deposited some of the arsenic which there was in excess of what it could retain permanently.

6731. Did Bostock's people use that?—They used it before the crystals appeared, I expect.

6732. It takes some time after it cools before the crystals appear?—Yes. Arsenic is a very slow substance chemically and physically, and evidently it does not come out of super-saturated solution for a very long time indeed, because the first sample that I received had been in the works for certainly a fortnight, probably much more, and I did not observe any crystals until some time after.

6733. Several weeks?—It begun to deposit perhaps within a week, but it had not completed the deposition two months afterwards.

6734. (*Professor Thorpe.*) Would not that circumstance rather indicate that the arsenious oxide was in some chemical combination with the sulphuric acid?—There is a compound known of SO_3 with arsenious oxide, and I believe this is not that, although I have not absolutely proved it. My evidence, so far as it goes, is two-fold. First I tried to get away as much as I could of the adhering sulphuric acid from the crystals without using water or altering in any way the composition, and then there was very little sulphuric acid remaining to be got on analysis, not enough to account for the compound SO_3, As_2O_3. The second piece of evidence is this. Here is a photograph of the original crystals which are prisms in the best sample I have been able to obtain. You may not be able to repeat that on the crystals I have handed in, but this is one sample which was particularly fortunate. On treating the microscopic slide, of which that is a photograph, with very little water, allowing it to pass below the cover, on the slide, as the water reached the acid crystals and diluted the acid—of course, a little heat was developed—a part of the arsenic dissolved, but the majority of the crystals underwent cleavage into imperfect octohedral crystals. Here is another photograph showing that stage. (*Photograph put in.*) It is not so good as it is in the microscope, because they are a little shaken, but you will see there the remains of some prisms that have cleaved into octohedra with flattened sides. Leaving that under the microscope and watching it, the imperfect octohedra began to grow, and they grow particularly on the flattened sides, so that in the course of an hour or two they are larger and perfect octohedral crystals. Here is a photograph of a more advanced stage, showing the perfect octohedra. (*Photograph shown.*)

6735. (*Professor Thorpe.*) That fact throws no light upon the nature of the arsenic in the solution?—No, except by inference.

6736. What you are illustrating is the well-known fact that arsenious oxide is dimorphic?—Yes, but I was using that as evidence that the crystals that come out are not the compound, but the arsenious oxide crystals in the labile form.

Dr. J. Brow
3 May
Selenium Nicholso acid.

6737. In addition to arsenic you also found that the sulphuric acid you examined contained minute quantities of selenium?—Yes.

6738. And the amount you set down on the average is about ·005 per cent.?—Yes.

6739. How did you estimate that amount?—I boiled the sulphuric acid with hydrochloric acid in order to convert any conceivable selenic acid into selenious acid, and I then passed sulphurous acid gas, and got a precipitate of elementary selenium, which I collected. I think I treated it with a little ammonium carbonate, and ultimately, when pure and dried, I weighed it.

6740. You have no doubt in your own mind of the identity of what you weighed as selenium?—None whatever. I proved that it was selenium.

6741. How did you prove it was selenium?—On other portions, not the portion I actually weighed, I converted into selenic acid, reduced it to selenious acid, then I converted into selenium sulphide, in some cases purifying that by ammonium carbonate and by sulphide of carbon.

6742. Did you find selenium also in the sulphuric acid which had been used?—Yes, but not in the elementary state. I also performed a colour test, which is not perhaps of much value, but I did perform the colour test with codeine.

6743. In this particular case?—On some of it.

6744. But you do not attach any importance to that?—I do not.

6745. You are aware, of course, that a large number of substances will give precisely the same colour?—Yes.

6746. Even arsenic acid itself?—But having heard of this being used, I used it for what it is worth.

6747. Do you think it is of no value?—I do not think it is of any value, but I have no doubt about the selenium.

No sele found Bostoc sugars.

6748. Did you make any search for selenium in the sugars?—Yes.

6749. Did you find it?—It was not a very perfect search: it was an afterthought; I did not find any.

6750. You did not find it in any of the sugars?—I do not think I found selenium in any sugar. I certainly failed to find it in any beer. I also added a small quantity of selenious acid to sugar and to beer, and afterwards analysed it, and I found that.

6751. What was the amount that you did add?—·01 grain selenium added as selenious acid per pound, equal to ·00014 per cent.

6752. Do you wish the Commission to believe then that had selenium been present to the extent you indicate, you would have been able to find it in the sugar you examined?—I think I should. I do not wish to be too positive about that because, as I said, my examination for selenium was not a crucial one. I did not work it out so perfectly as I should have done had I tackled it earlier. For instance, I am not prepared to go into a witness box and declare upon oath that there is never any selenium in the sugar.

6753. The sugars that you did actually examine, apart from the synthetic experiment you made, were those Bostock's sugars?—In all cases.

6754. But did they contain arsenic?—Large quantities of arsenic. The figures of the quantities of arsenic in those Bostock's sugars I have handed in, and I feel quite convinced that there was not so much as ·01 grain of selenium per pound.

6755. Selenious acid or selenium?—Selenium in any form calculated as elementary selenium.

6756. Have you anything to tell the Commission beyond what is here in your précis, which you hand in, as to the modes in which arsenic finds its way into beer?—There are two sources, the arsenical glucose and the arsenical malt. I have nothing to add to that.

6757. Now we come to the method of testing. You state at some length your modes of testing, both qualitatively and quantitatively, for arsenic. Perhaps you would explain in detail to the Commission what you have to say on that point?—It is a rule in my laboratory that any analyses of a substance in such a condition that it may come into court, shall be analysed by two different hands, generally one under my super

vision, or Mr. Williams, my chief assistant and colleague's supervision, and one by another skilled chemist, working quite independently, and further, if possible, by two different methods, so that not only do we have two independent analyses, but the check that two different methods afford to prevent the possibility of an error slipping through. In the case of the arsenic in the beer, those two methods were, first a purely qualitative test which gives, carefully performed, a pretty good general idea of quantity within certain wide limits. The qualitative test is to take a small quantity, not 200 or 250 cubic centimetres, but 30 cubic centimetres, or 50 cubic centimetres, in a small flask; add 10 per cent of its bulk of pure hydrochloric acid, which has been tested and found absolutely free from arsenic, and add a piece of thin electrolytic copper foil about 5-16ths of an inch square; boil vigorously on a sand bath for half an hour; pour off the beer, and note the appearance of the copper. If it is not thickly coated, return the beer to the flask and boil for another half an hour, and again pour off and examine the copper. If the copper is now thoroughly coated it is removed, washed and dried, but if there is only a slight coating, a slight tarnish, it is returned to the flask and the boiling continued with the beer for another hour, that is two hours altogether, then removed, washed and dried. If the copper has been removed before the whole of the arsenic has been deposited, which often happens, a second piece of copper is added and boiled for an hour, or whatever time may be necessary, until you are satisfied that all the arsenic obtainable in that way has been removed upon the copper. The reason for not continuing with the same copper is that when the deposit becomes thick it is apt to scale off either in the flask or later, when it has been transferred to a tube. The dry copper is then rolled into a cylindrical form and introduced into a clean dry tube of hard glass, 3-32nds of an inch diameter internally, or about that, about 2½ inches long, previously warmed in a flame. The end of the tube containing the copper roll is very cautiously heated, holding it first about an inch above one of the flames of a Bunsen rose burner, turned very low, and when the arsenic has left the copper, it is driven slightly up the tube to a clean part by holding the tube rather nearer the flame. During the sublimation the tube is held nearly horizontally. That is an ordinary method of examination, and it is only made very precise for the purpose of getting an approximation to a rough quantitative idea.

6758. In other words it is the Reinsch method, of which you have given us so full details of the way you carry it out?—Precisely.

6759. Having in this way got some rough idea of the quantity, how do you proceed to more accurately estimate the quantity?—I then take another portion, much larger, a litre or a litre and a half, or 2 litres if possible of the beer, and analyse it by Fresenius's well-known method, with a slight deviation, for an object that I will mention. It is evaporated first in a large porcelain dish on a sand bath to about 250 cubic centimetres. The dish is then transferred to a boiling water bath, 75 c.c. of pure concentrated hydrochloric acid added, and then 2 grams at a time of potassium chlorate, with constant stirring until a thin yellow liquid is formed, and then a further 2 grams of potassium chlorate is added, and it is allowed to cool. When it is cool it is filtered, washed and evaporated, so as to get off the whole of the chlorine or chlorine compound that is evolved. Again it is allowed to cool, and saturated with sulphur dioxide to reduce the arsenic to the arsenious acid. The sulphur dioxide is evaporated off, and then the hot solution is treated with sulphuretted hydrogen, heated in a water bath ultimately to nearly expel the sulphuretted hydrogen. It may be necessary to continue passing the sulphuretted hydrogen gas for hours, or it may be all finished generally in an hour. In this case an hour is enough, I think. Then the precipitate is filtered and washed to free it from chloride, which is very important; and it is digested at this stage with a hot mixture of 2 volumes of 5 per cent. solution of ammonium carbonate with 1 volume of 10 per cent. solution of ammonium hydrate, the liquid being poured repeatedly through the filter. This is for the purpose of dissolving at this stage the arsenious sulphide, and getting rid at once of any antimony or lead, or metals of that kind that might be present as impurities. The usual way is to leave that till later. I find it better to get that done at this stage. Then the solution is evaporated to dryness, the residue moistened with fuming nitric acid free from chlorine; the solution is evaporated to dryness, and the yellow residue moistened with concentrated sulphuric acid and heated in a water bath for an hour. To the thick black solution thus formed a few small pieces of Swedish filter paper are added to render the mass pasty—this is taken from Fresenius—transferred to an air bath, and heated to 160° centigrade, taking great care that the heat never exceeds 170°, until the mass is friable and yields a colourless solution. That is a process of charring, which effectually reduces arsenic acid to arsenious acid. The residue is then extracted with hydrochloric acid dilute. The residue is filtered and washed with water containing hydrochloric acid, and then precipitated in hot solution with the sulphuretted hydrogen again. It is warmed in a water bath to expel the excess of sulphuretted hydrogen. The precipitate is washed, dried and digested on the filter paper with bi-sulphide of carbon in a small beaker, that is to remove sulphur that may be present as sulphur, and then is dried and digested with about 15 cubic centimetres of a hot mixture of ammonium carbonate and ammonium hydrate as before. This solution is filtered and evaporated to dryness in an accurately weighed porcelain dish or capsule, carefully dried at fully 100° until the weight is constant. The precipitate is now probably pure arsenious sulphide. If it is not, it is re-dissolved and the whole purified again, and re-precipitated. In good hands that is seldom necessary. If it is necessary I find generally that the weighing after and the weighing before the second purification gives exactly the same figure.

6760. Would you kindly explain why you think it necessary in the case of beer to make use of the same drastic method of breaking up the organic matter, that you would do in an ordinary toxicological enquiry. In the first place, perhaps you might tell the Commission how far you think there is any direct evidence of the formation of any combination of organic matter in beer?—Those are two quite different questions.

Question of combination of arsenic with organic matter of beer.

6761. Perhaps it would be better to begin with the direct evidence as to the possible occurrence of any organic combination of arsenic in beer?—There is a little ambiguity in the phrase "organic combination." I will divide that into two parts if you will allow me. In December last I thought it was quite a possible thing that there might be some compound of arsenic other than arsenious oxide. Medical men were expressing considerable doubts whether the poisoning that took place was due to arsenious acid, and whether there might not be a more poisonous compound not known. I therefore took a large quantity of a certain barrel of implicated beer and distilled it, once into an acid dish, and once into an alkaline flask, and examined both of these for arsenic, but I found nothing, and I am satisfied that there is no very volatile compound of arsenic present in beer. There is no cacodyle or homologue of cacodyle. Moreover, the odour of beer would be offensive if these were present, and I am quite sure that they are not. Also, I did not feel the necessity that medical men felt for supposing that there was some extra poisonous body, because I account for all they feel difficulty about in another way. First, the large quantity of liquid very easily absorbed brings the arsenic quickly into the circulation, and it all acts or gets an opportunity of acting, whereas where they administer arsenic in the ordinary way, or particularly when arsenic is administered as a poison, a portion of that, and sometimes a very considerable portion, never gets into the circulation; it passes out through the fæces in all probability. And secondly, it is perfectly clear to me now that on the whole the quantity of arsenic present in beer has been very generally and very greatly understated, so that the quantities that have been drunk have been much greater than medical men suppose. I think those two things may account for all that they find a difficulty about.

Amount of arsenic in beer often understated.

6762. (*Chairman.*) There was more arsenic than the analysis had shown?—Yes; as a rule, and considerably more than the medical men have been told, or that they have gathered has been present.

6763. (*Sir William Hart Dyke.*) Do you mean analysed since this epidemic or previous to this epidemic?—Since this epidemic. Before the epidemic they did not suppose there was any arsenic in beer. It was exceedingly difficult to convince them that there was.

6764. (*Chairman.*) Do you think that probably before the epidemic there has been a deleterious amount of arsenic in many beers?—Undoubtedly.

Beer arsenical before the epidemic.

6765. (*Professor Thorpe.*) What is your evidence for

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that. You say you are undoubtedly of opinion that there was a considerable quantity of arsenic in beer before the epidemic manifested itself. Is that what I gathered you to say?—Yes, in some beer.

6766. What is the evidence you have of that?—That is a somewhat long story. In the course of the examination of the implicated beer several brewers asked various chemists, including myself, to help them to get the arsenic entirely eliminated from their works, and for that purpose they brought samples of the beer before it was finished, at various stages, from the vats, and I found that the arsenic did not disappear so quickly as I thought it ought to disappear after the use of Bostock's sugar was discontinued. We thought that it might be arsenic adhering to the vats and various pipes, and other portions of the plant. That was carefully investigated. I had shavings taken off the vats and every imaginable thing examined, with the result that we found that all the arsenic had been completely cleaned out of the plant; there was nothing left there. Then we tried all the materials, and we found arsenic in yeast.

No arsenic in brewing plant.

6767. (*Chairman.*) In yeast that had been used before the epidemic?—In the yeast that was being used after Bostock's sugar was discontinued.

6768. That was a continuation of the yeast that had been used during the time of Bostock's sugar?—At first it was. Then they discontinued their own yeast, and sent to a brewery in the Midlands for a fresh supply of yeast and brewed from that, and still arsenic was found in the product. I then asked for a specimen of the yeast as it came from the Midland Brewery, which was one that used no sugar of any kind, brewed solely from malt and hops, and I found as much arsenic there as in the yeast that had come from beer that had been in contact with Bostock's sugar. They were no better for getting fresh yeast than by using their own. We pursued the search for the source of the arsenic, and very soon found that the source was malt. Of course, we then stopped the malt and told the medical officer. However, he did not require to take any steps, for the maltsters, who were very concerned about this, came down by the next train with specimens of their barley and their fuel. Of course, we had to forbid the use of the arsenicated malt. The result of the investigation and the efforts of the maltsters was this. I will give you the result of the examination of typically good fuel. Anthracite, which contained only ·0075 of arsenious oxide per cent. and coke, which contained only ·0035 and ·0025 of arsenious oxide per cent., was used with certain samples of malt, and the malt dried with that fuel, which is the very best fuel in England, contained ·064 grains of arsenic per pound—1-12th of a grain per pound on the surface of the malt. That was what some of the best beer was being brewed with.

Amounts of arsenic in malt.

6769. Was that malt which had already been brushed and screened?—No; that had neither been brushed nor screened.

6770. Would it be brushed and screened before being used by the brewer, or might he ignore that?—Not in that case. I will tell you the result of brushing. The same malt, after being brushed and screened, contained only 1-80th of a grain per pound, which was of little consequence; and when it had undergone the process of brushing three times we could hardly detect—we could just detect it—but we could hardly detect the arsenic at all. I should say here that when the malt is crushed up and mashed, and the arsenic extracted from that, you do not get the whole; some of the arsenic so combines with the organic matter that you cannot practically get it out unless you destroy the whole of the malt, which is a very slow and tedious process, and quite unnecessary, because, if the malt is left entire and washed well with water containing a small quantity of alkaline carbonate, the arsenic dissolves quite readily, and we get practically the whole easily in that way, and then estimates of the quantity were obtained in that way.

Improvement on brushing.

6771. Would the washing not bring it out from the crushed malt?—Not entirely. From the crushed malt you do not get it all out entirely by the water. Some is lost by adhering to the solid matter of the malt.

6772. (*Professor Thorpe.*) What you mean to say is this in effect:—that when great care such as you have mentioned is taken in the preparation of malts from fuels which are reasonably free from arsenic, nevertheless arsenic can be found in the malt?—Yes.

6773. And you infer from that, that inasmuch as malt of even worse character as regards arsenication must have been previously used, therefore beer containing arsenic must have been in vogue prior to the epidemic?—Yes, but I am more precise than that.

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6774. What more evidence is there, then, as to the amount?—In the course of examination of other samples of beer that we condemned for containing arsenic concerning which the brewers declared, and with truth, I believe, that the beer was brewed entirely from malt and hops, we asked for samples of the malt, and we obtained the following figures from different samples: 1-9th of a grain of arsenic per pound; 1-7th of a grain of arsenic per pound; 1-6th of a grain of arsenic per pound; another one 1-6th of a grain of arsenic per pound; and one contained as much as 1-4th of a grain of arsenic per pound.

Arsenic in malt.

Quantities found.

6775. (*Sir William Church.*) Were those unbrushed malts?—Yes, as they came from the maltsters, and as they were being used by the brewer, and beer which we were credibly informed was made from two of these arsenical malts contained as much as 1-5th of a grain of arsenic per gallon. Of course, that beer was condemned, and it was all destroyed, but if it had not been interfered with that would all have been sold with a guarantee, probably, that it was made from nothing but malt and hops; and if that was occurring several weeks after the scare was made public, of course there is no doubt it was happening several weeks and years before the scare.

Arsenic in all-malt beer.

6776. (*Professor Thorpe.*) Do you wish the Commission to believe that beer brewed from malt and hops under normal conditions contains as much as 1-5th of a grain per gallon of arsenious oxide?—Yes, it did sometimes.

6777. Do you think it is a common occurrence with beer?—I should think not; I should think it is a very uncommon occurrence, but if malt is dried with gas coke, as it sometimes is, then I should think it was very likely to occur in such malt unless it were carefully brushed.

6778. Have you reason to believe that evil consequences would result from drinking beer containing as large a quantity as one-fifth of a grain of arsenic?—Medical men say that serious consequences occur from drinking much less.

6779. Is there any evidence of the occurrence of anything approaching in character this epidemic during the last forty or fifty years when that character of beer must have been in vogue?—That is a medical question which I am not qualified to go into, but there is undoubtedly a considerable impression arising in the minds of medical men that some of the symptoms of what they call peripheral neuritis that had been observed before the epidemic may have been due—I only say may—to arsenic in beer, which has come from other sources than sugar.

6780. But this character of beer that you are mentioning is the universal type of beer; it is the beer which has been brewed all over the country?—It is very seldom, I hope, made from malt which has been dried with gas coke.

Arsenic in malt diminished since epidemic.

6781. (*Sir William Hart Dyke.*) Did you discover what fuel had been applied to this malt?—I was not, of course, able to arrive at that. The maltster was naturally very reticent about that; but I have no doubt whatever that it was gas coke; and I may say that he has since then discarded his process. He has also changed his fuel, brushed the malt, and has reduced the quantity to what may perfectly well be neglected. In the present year, after maltsters had been warned to brush their malt, figures were obtained showing 1-18th of a grain of arsenic per lb., 1-22 of a grain of arsenic per lb., 1-80th of a grain of arsenic per lb., and during the last month the quantity is so minute that I sometimes cannot identify it from a pound of malt.

6782. (*Professor Thorpe.*) Does this finish all that you have to say as to the evidence that there may have been a considerable quantity of arsenical beer in existence prior to the epidemic?—Of slightly arsenical beer.

6783. I do not quite understand why peripheral neuritis, then, under those circumstances should not have been more widespread than it apparently has been?—May I point out first that the quantity of beer containing so much as from 1-10th to 1-5th of a grain has undoubtedly been a very small proportion of the total made; secondly, that a considerable number of maltsters did brush their malt before the epidemic; thirdly, that many brewers brush their malt somewhat after it comes from the maltsters. All these lessen the risk; fourthly, the number of people drink-

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ing a very large quantity of beer is quite limited. You have to have a coincidence of five things before you have the probability of neuritis.

6784. I must point out to you that these coincidences are just as likely to happen in Bristol, Plymouth, Southampton, London, or anywhere you like where large quantities of beer are drunk?—Then I would next point out to you that medical men say there has been a considerable prevalence of slight peripheral neuritis in the North of England as compared with the districts round London and Scotland. In places where beer has been drunk in large quantites, three gallons of beer a day, you have had peripheral neuritis, and the question with them is whether that has not arisen from this imperfect malt.

6785. (*Chairman.*) Are there differences between the northern districts and the districts round London? Are there more cases of excess of beer drinking in the North than in the South?—I do not know that. It is very difficult to find out how much beer a person drinks. He is very unwilling to tell.

6786. Are there differences between the malts in the northern districts and the malts in the southern districts? Do you see any reason for supposing that there were more case of arsenic in the northern district malts than in the southern district malts?—I have no means of knowing that, because I have had no experience of the southern malts; but I have had some amount of evidence of what has been sold in the North and in the Midlands.

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6787. (*Professor Thorpe.*) To bring you back to the point which we somewhat departed from, you told us how you eliminated in your mind the possibility of the occurrence of cacodyl or anything analgous to cacodyl as a form of organic combination of arsenic. But you said, apart from that, you had reason to believe that the arsenic was in some form of combination with the organic matter, because you had to destroy that combination by the method you have told us. What is your evidence for that?—My supposition does not go further than that the arsenious oxide itself is combined with organic matter, and is held back and prevented from being precipitated much in the same way that iron is held back by organic matter, sugar and so on, from being precipitated by ammonia. It is not necessary to suppose, although it may be true, that the arsenic is combined with organic matter in the same way as iron is combined in ferrocyanide. It is quite enough that the arsenic should be, as arsenic, combined with organic matter in some way that prevents precipitation. I do not know further than that.

6788. That is a surmise?—No; I do not surmise; there is something more than that.

6789. But you surmise to that extent, viz., that there is some agency, which you call organic matter, which keeps the arsenic up and prevents it from being thrown down by the ordinary tests which chemists apply for its discovery?—I do not surmise that. That is a fact which I find by experiment.

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6790. Perhaps you will explain to us, then, how you find it?—Here is an example of the evidence, four analyses for comparison. First, an arsenical beer that I know all about is taken. One litre of the beer is concentrated, is acidulated, heated and precipitated by sulphuretted hydrogen, the gas being passed until the laboratory is closed for the day. It is allowed to stand all night, and then it is not quite clear in the morning. Then the beer is filtered, and the precipitate is examined. The filtrate is again heated and treated for nearly a day with sulphuretted hydrogen and filtered. The beer filtrate from the arsenic deposit is again treated with sulphuretted hydrogen and the following day that is filtered, and the precipitate examined. The filtrate is so treated for a third and a fourth time, with a precipitate in each case more or less, and each precipitate has the arsenic estimated in it. Finally, the filtrate is oxydised to destroy the organic matter, and the arsenic is estimated by precipitating as sulphide distilling with hydrochloric acid and weighing finally as sulphide. The first precipitate yielded ·001 gramme of arsenious sulphide.

6791. When you say the arsenic is volatilised by distilling with hydrochloric acid, do you mean you treat an impure sulphide with hydrochloric acid and distil it?—Yes.

6792. That is all you do?—I treat it as nearly as I can by the Somerset House method.

6793. I should like to know exactly what you do?—For my present purpose it is not necessary to say, I think, how I do it. I get so much arsenic by any reliable way I do not lay stress upon the method there. It is the previous part that I lay the stress upon.

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6794. Pardon me, this is very essential. You get an impure sulphide of arsenic which you purify in the manner you described, but not fully described. I should like to know exactly what you do?—I was only trying to save time. I will take the first precipitate.

6795. Cannot you shortly describe what you do with these arsenical precipitates? They are all of the same character?—The precipitate was washed, slightly dried in the water oven for an hour or two; the filter with the precipitate was placed in a distilling flask, and strong hydrochloric acid added with ferric chloride and ferrous sulphate, and was then distilled into water; a further quantity of hydrochloric acid was added and distilled again; and this was repeated until there was no arsenic left.

6796. That is all I wanted. I merely wanted to get certain additional details which you have now given, which you did not give before?—I did not think it was necessary. That was finally obtained as arsenious sulphide and purified, dried, and weighed.

6797. Will you tell us shortly what was the effect—that you did not recover all the arsenic that you knew to be there?—The first precipitation with sulphuretted hydrogen yielded ·001; the second yielded ·0005; the third yielded no arsenic; the fourth no arsenic; and there was left in the filtrate, and recovered after destroying the organic matter, ·0055, making a total of ·007 of arsenious sulphide, which corresponds to ·39 grain of arsenious oxide per gallon.

6798. What was known to be there?—I am coming to that. In the second experiment a similar course was pursued, except that after the fifth precipitation a good deal more hydrochloric acid was added before passing the sulphuretted hydrogen, and a good deal of the sixth precipitate was obtained. There was a seventh precipitate obtained before the final filtrate was taken for the destruction of organic matter. The result was that the first precipitate yielded ·001 as before. It may be a coincidence, but it is a remarkable one. The second one yielded ·002, much more than the previous one. The third, fourth, fifth, sixth, and seventh yielded no arsenic, and there remained recoverable after destruction of the organic matter ·004, which brings up the total to ·007, as in the first experiment.

6799. (*Sir William Church.*) Were those the same beers?—The same beer.

6800. (*Professor Thorpe.*) Does that mean that when you pass successively sulphuretted hydrogen and allow the liquid to stand, and filter it, you get the arsenious sulphide down little by little?—No.

6801. Yes, you do. Some of the arsenic remains in solution; but notwithstanding your arsenious sulphide is coming down little by little?—No; it only comes down in the first and second precipitations. It does not come down in the third, fourth, fifth, sixth, and seventh days' passing of gas, and the great bulk of it remains in the final filtrate.

6802. (*Chairman.*) So that you get four by your final process, whereas the previous process only gave three?—Yes, making a total of seven milligrammes.

6803. That was all you could get out?—Yes, in the second experiment. In the first experiment we got ·0055 by the last process, and only ·0015 by the other. In the third experiment another litre of the same beer, first destroying the organic matter, gave the whole precipitate at the first passing of the gas in a much shorter time, and it amounted to .007, the same total as before.

Pure beer after addition of arsenic behaves differently to beer brewed with arsenic.

6804. In this last case you oxidised the organic matter in the beginning?—Yes, and then you get the whole of it at once. In the fourth experiment pure beer was taken, and ·0052 gramme of arsenious oxide added to a litre of the beer. The organic matter was not destroyed; it was acidulated, heated, and the gas passed direct, and the whole of the arsenic was obtained in the first precipitate. That is the sort of evidence I have that the arsenious oxide is compounded to some extent with the organic matter so that it is not precipitated.

6805. (*Professor Thorpe.*) Is what you wish us to believe that when you add, we will say, arsenious oxide to finished beer, you can by the ordinary well-known methods recover it?—I hesitate to take the word

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"well-known methods." I say they are all well-known methods.

6806. Your method?—The simple method without destruction of organic matter.

6807. You recovered it by your method straight away?—I recovered it by simple precipitation as if the organic matter was not there.

6808. When, however, the arsenic was brewed with the beer you could not recover it?—That is so; not nearly the whole of it. It may have been due to the brewing or to long keeping, or it may have been due to other substances that they add. It may be the sulphite, or it may be any conceivable thing; but as a matter of fact the beer which was brewed and treated in various ways—we do not know how—and that was sold, did not yield more than a fraction, and a varying fraction, of the arsenic known to be there, until the organic matter was destroyed.

6809. You say somewhere or other in your *précis* that the fact, namely, that you cannot recover the arsenic from the beer, has been known to you for 25 years?—I did not say beer. I said organic matter.

6810. I understood you to say that the fact that you could not recover the arsenic from beer has been known to you for 25 years?—I did not intend to say beer, but from the organic matter containing arsenic.

6811. (*Chairman.*) You distinguish between arsenious acid added to the beer in one experiment and arsenious acid that has somehow or other got into it in the brewing or manufacture?—What I mean by that is exactly this, that the finding of all the arsenic from a mixture which anybody makes with pure beer for comparison is no argument in favour of the idea that you get all the arsenic by the same method from what you call Bostock's beer. The importance of that lies in this, that the various gentlemen who have applied various processes, with what I believe to be incorrect results, have generally used the argument that they have compared the results with the quantities added by themselves, but they have added those quantities to beer already brewed, and that is the fallacy. They are not justified in assuming that the results are correct when that is all their evidence.

6812. (*Professor Thorpe.*) If it is shown to you that no matter whether the arsenious oxide is added to the finished beer, or whether it is added to the wort, and the beer is brewed, and the results are the same—supposing that is proved to you, what becomes of the supposition that there is some combination formed in the process of fermentation?—That evidence is not crucial enough. It does not disprove the fact that you do not get nearly all your arsenic from Bostock's beer, whatever the reason may be. If you can make beer to which you add arsenic and can get the whole of the arsenic, it does not prove that I get all the arsenic from Bostock's beer, or that you would get all the arsenic from Bostock's beer.

6813. It proves that both of us ought to?—No, I do not think it does. It proves that something happens in Bostock's beers that does not happen in others.

6814. (*Sir William Church.*) You have said that "when sulphuretted hydrogen is passed into acidulated arsenical beer, whether concentrated or not, only a portion of the arsenic is precipitated; this is a colloid precipitate which does not coagulate well, and it is very difficult to filter. An unknown but large proportion remains in the beer. This has been known to me for 25 years." That is, I think, what Dr. Thorpe was alluding to?—I do not mean beer specially. It is badly worded. What I meant there was that as applied to the presence of arsenic in organic matter generally, and not specifically beer, that fact has been known. I did not actually think of beer 25 years ago. If I had I should have known that.

6815. But this peculiarity of the precipitated sulphide has been known to you for 25 years?—Yes, that peculiarity of the sulphide of arsenic and the fact that you could not get it from organic matter without destroying the organic matter, has been well known to me and others for more than 25 years.

6816. (*Chairman.*) Instead of the words "arsenical beer" in this statement, you would substitute acidulated vegetable or animal organic matter containing arsenic?—Yes.

6817. This statement will be correct then?—Yes, if you make that correction it is strictly right.

6818. When sulphuretted hydrogen is passed into acidulated organic liquid matter containing arsenic, whether concentrated or not, only a portion of the arsenic is precipitated. This is colloid precipitate, which does not coagulate well, and it is very difficult to filter. An unknown but large proportion remains in the beer. This has been known to me for 25 years?"—There, if you put "remains in the liquid," take out the word "beer;" then it will be right.

6819. "An unknown but large proportion remains in the liquid?"—That will then be quite right.

6820. (*Dr. Whitelegge.*) That would not be strictly true of arsenic newly added?—In the case of this test that I made I was surprised to find that I did get the whole of the arsenic down. It had not in the short time, I suppose, under the circumstances compounded itself in such a way that it was held back. It is a very slow thing. It does not compound itself quickly, and does not come out of the compound quickly.

6821. The proposition would relate not quite strictly to all arsenic present in organic liquid, but to arsenic that has had time to assume some change?—Some unknown change. I do not know what the change is.

6822. (*Sir William Church.*) I understood you to say to Dr. Thorpe that the fact of his being able to recover the whole of his arsenic from beer brewed from arsenical materials would not satisfy you that in another case of a beer brewed with different arsenicated materials you would be able to do it?—The experiment he alluded to is a very important one and a very interesting one.

6823. But it would not be to you conclusive that the same would occur under all circumstances?—No number of negatives of course can disprove my positive, and it is not my positive alone. These four experiments I have just alluded to are typical, and they were very carefully done by undoubtedly correct methods.

6824. Had you any further experience of the same sort?—Yes, there are some others which are not quite in a fit condition to be sent up here in the shape of figures. When I got sufficient evidence I did not go further for myself. I am quite satisfied, but if the further details will be of more satisfaction to you I can send you more from another strength of beer.

6825. You have had other details which confirm in your own mind that opinion?—Yes, I had further evidence which is of some importance. I have some dishes here which I should have produced before. These dishes show the amount got in the different precipitations.

6826. (*Chairman.*) What is the yellow matter we see?—That is the sulphide of arsenic. This dish shows a precipitate which was before the Courts, and, I think, will be again. That corresponds to 1-5th of a grain per gallon.

6827. (*Dr. Whitelegge.*) These actual samples were not weighed?—That was a sample I weighed in the porcelain. It was carefully dried and weighed fresh from the desiccator.

6828. (*Chairman.*) How did you weigh this precipitate, because we here see it a hard coating on the porcelain?—The dish is carefully dried in a desiccator, taken from a desiccator and weighed, and that stuff is got into it and weighed again.

6829. The weight of the dish is taken, and after that it is weighed with this precipitate?—Yes.

6830. What is the actual weight of this precipitate, 1,354 R.D.?—That weighs ·006 gramme. That was from 1,500 grammes, a litre and a half of beer. What I wanted to say about that is this, that other gentlemen working by mirrors and other guessing methods, call that 1-30th of a grain, 1-15th of a grain, 1-40th of a grain, and Somerset House return it 1-30th of a grain.

6831. (*Chairman.*) And you find it to be 1-5th of a grain?—I find that amount which corresponds to 1-5th of a grain per gallon. That is an actual case, and it was that which led me to go into all these details. There is a corroboration of the substantial correctness of the figure 1-5th of a grain per gallon, in the fact that I was subsequently informed that the brewer of the beer was supplied with malt by the same maltster who supplied the two samples in which I have already mentioned we found 1-6th and 1-9th grain arsenious oxide respectively, and which corresponded with 1-5th of a grain arsenious oxide in the beer which was brewed solely from them and hops.

Divergence of results obtained by different analysts applying different methods to beer.

6832. (*Dr. Whitelegge.*) Would you say that whilst the other methods of analysis may omit some arsenic,

in the way you perform the experiment there cannot be an over-statement?—That is an under-statement, because I lose a little. In comparing the two methods I find such figures as these, ·35 instead of ·39 grains per gallon. I lose, therefore, a small fraction like that. What I say is, that when I get that, and produce it, and weigh it absolutely pure, there is at least that amount, there cannot be less, unless I have arsenic in my materials. I wish to state to the Commission the precautions I take to prevent error from the materials employed. First, every batch of every re-agent is tested, every Winchester quart, or every bottle of hydrochloric acid, is carefully tested, and if there is the slightest trace the bottle is rejected and not allowed to enter the place. Secondly, blank experiments are made with the same quantities of exactly the same ingredients that were employed upon that beer, in that experiment, using pure beer in the same quantity, with the result that we get a blank dish, no weighable quantity of anything. There is a third corroboration of that, that with the same ingredients we have estimated much smaller quantities of arsenic in both beer and malt, and have found quantities as low as 1-70th and 1-80th, and less. Now, if the impurities came from the ingredients, we should never find so small a quantity as 1-70th, it would be impossible. We should find the same quantities of impurity every time. Therefore, I think the evidence is absolute that at least that amount of arsenic was present there.

6833. (*Chairman.*) What are the weights of the first and second precipitate in experiment A?—·001 gramme is the weight of the amount precipitated on the porcelain there.

6834. One milligramme on the porcelain?—Yes. You have the figures down.

6835. I wanted to know the weight on the porcelain?—·001 gramme on that porcelain from a litre of the beer.

6836. On the second porcelain, what is the actual weight?—·002.

6837. Then on the third, fourth and fifth we have nothing?—Nothing.

6838. And nothing was shown in weighing?—No.

6839. On the sixth we see nothing?—That is after the addition of more hydrochloric acid, and the further precipitation of sulphur and organic matter, and there is no arsenic on the porcelain.

6840. And no addition to the weight of the porcelain?—None.

6841. And the seventh of experiment A. was that still with further hydrochloric acid?—That is simply the filtrate from the sixth, and there is nothing there.

6842. Now the final precipitate?—·004 gramme.

6843. The weight of this precipitate then is four milligrammes?—Yes. They are the figures I gave you before, dish A is the second experiment, and then I gave you the calculation into grains per gallon, which was ·39. It is the same for B. I have the B dishes if you would like to see them, they correspond to the first experiment which I mentioned.

6844. Can you tell us the smallest quantity of precipitate on the porcelain that you can weigh?—I do not think I can, because it depends on the balance. I have a balance that I could employ if I wish to do it, that would give 1-10th of a milligramme or less; but I do not think it necessary to use that.

6845. What is the weight of the porcelain itself?—It varies, say, 19 grammes for a large precipitate, and five grammes for a small one.

6846. And you can weigh 1-10th milligramme on 19 grammes?—I should think one might do so, but I never did it. I do not trace the fractions of a milligramme beyond a half or a quarter. I should not trace my ordinary work to the 1-10th of a milligramme, but it can be done when desirable.

6847. Have you any case in which the precipitate is visible, and yet not perceptible on your balance in this experiment?—No yellow precipitate.

6848. If it is visible at all you would be able to weigh it in the balance?—Yes, in that experiment.

6849. Do you think there is any case in which you could weigh it in the balance, and yet it is not perceptible to the eye?—Not the arsenious sulphide; I can see as little as I can weigh; but I think I ought to say here that in official work there is always the check of the Reinsch test. I will give you a very important example. In some of the evidence that has been given before you, I learn that you were a little concerned about a certain preliminary report that I had made regarding a sample, calling it a "small quantity" in one case, and saying merely "arsenic" in another. When I came to the figures I did not get quite so much from the sample that was recorded provisionally as simply arsenic, as I got from the sample which was recorded as a small quantity, and I was not quite satisfied with the result, because it did not quite agree with the Reinsch indications, which indicated rather a larger quantity from the one recorded as simply arsenic; and I repeated the analysis, so that by the time the case came into Court I was able to prove a larger quantity. Some had been lost in the first estination. There is an illustration of the use of the second process as a check.

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Tests for arsenic in beer compared.

6850. What do you call the second process?—The Reinsch test

6851. What you stated as to the necessity for oxidising away the organic matter, does that apply to the Reinsch test as well as to the precipitation test?—Not nearly so much. I think we do not quite get all the arsenic down by the Reinsch test, but we get a very much more nearly total quantity than we do from the Marsh, or by simple precipitation by sulphuretted hydrogen.

6852. The precipitation by sulphuretted hydrogen is surer than either of the other two tests?—For quantitative purposes, provided the organic matter has been first destroyed, otherwise it may be worse.

6853. So that the Reinsch test is not so much affected by the peculiar organic affinities you have discovered?—Not if you boil long enough; but the one hour generally employed is often not sufficient unless your object is to fail to get small quantities of arsenic.

6854. What about the organic affinity you have discussed, and the Marsh test? Will it vitiate the Marsh test?—I have five objections to the Marsh test, of which that is one.

6855. You consider that the Marsh test is in this respect worse than the Reinsch test?—Immensely so. Twenty years ago it was my duty, along with another very careful and reliable chemist, to investigate a series of murders by arsenic in which there were many victims. In one case of a child there was a very small quantity of arsenic. We applied the Reinsch method and we applied the Marsh method. The quantity was far too small for weighing, and we failed to get evidence we could use for judicial purposes by the Marsh test. But we got perfectly clear and unmistakeable evidence by the Reinsch method, and on that we gave evidence in Court. I instance that as a crucial test made under circumstances of a strong feeling of responsibility. Since that time we have never relied upon the Marsh test where there is organic matter.

6856. On that occasion, did you use the method of oxidising the organic matter?—Not in that one particular body, because the quantity was much too small. In the case of other bodies at the same trial we did. We used very much the method I have described, but we went further, and instead of stopping with that yellow precipitate, we oxidised it and converted it into arsenic acid, and precipitated it as arsenate of silver, which gave a further link in the chain of evidence. I do not go so far as that in beer analyses for two reasons. First, we have got our confirmation by the octahedral crystals from the Reinsch test, and that is confirmation qualitatively, and the yellow precipitate in that test is an exceedingly good one to show to a magistrate, or to this Commission. Here are the crystals. (*Tube shown.*) You see there the crystals obtained by the Reinsch method from an ounce of beer (No. 858), and there is another tube containing the crystals from an ounce of beer. This is the porcelain dish 858. I certified 1-10th, and I found 1-9th really, and there is the arsenic in the form of sulphide. I have handed you the rough tube containing only a portion of the crystals from an ounce of the beer. You could not possibly produce those crystals in such quantity from an ounce of beer if there was not at least 1-10th. Two other gentlemen found 1-80th and 1-100th of a grain. Somerset House certified 1-100th. Dr. Stevenson estimating it, of course, not precisely, can easily distinguish between 1-100th and 1-10th by the Reinsch test: he applied both Reinsch and Marsh tests, and he says that from these he makes it to be ·17 of a grain per gallon. In a letter to me, he says he believes that these esti-

Divergence of results of different analysts using different methods.

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mates of his are correct within 20 per cent. If you take 20 per cent. off that, you still have 1-7th of a grain per gallon against my 1-9th.

6857. So that that agrees with your 1-9th?—He makes it a little more than my 1-9th. Then to Mr. E. W. T. Jones, a very careful public analyst at Wolverhampton, I sent a small quantity only, and using 50 cc. in Reinsch's method he also says there is at least 1-7th; so that there is Stevenson by Marsh and Reinsch, and Jones by Reinsch alone, and myself, and I think five of my assistants, each separately getting over 1-9th by Reinsch's test, and there is finally my precise estimate in that dish of 1-9th.

6858. How much was the amount weighed on this dish, No. 858?—·003 of a gramme from a litre and a half.

6859. In this case it was just one precipitation. You had taken your proper precaution of oxidation beforehand?—Yes. That was my final method at that time.

Nicholson acid supersaturated with arsenic.

6860. (*Sir William Church.*) Going back to what Dr. Thorpe was asking you, is the slow deposit of arsenious acid from sulphuric acid a well known and a regularly recognised fact?—Not until last year. No one has ever seen, as far as I can ascertain, anything like such a quantity of arsenic in sulphuric acid before. The largest that people are acquainted with is about 1-5th of that.

6861. (*Dr. Whitelegge.*) Even in Glover tower acid?—My 2·6 per cent. sample is called the record, I think.

6862. (*Sir William Church.*) You think it is quite possible that when Messrs. Bostock had this acid delivered to them there was nothing peculiar in its appearance?—There was nothing when it was delivered to them, and there was nothing when I got it from them first on the 27th November last. It would not have attracted attention then as being anything out of the way. If it did deposit, it would not be seen in the carboys.

6863. With regard to the malts you spoke of, are you well acquainted with malt from different parts of the country?—I have examined malts from different parts of the country.

6864. I ought rather to say, with the process of malting?—I know something about it.

6865. We have had it stated in evidence before us here that the south country maltsters almost all use anthracite coal?—Then their beer will be undoubtedly purer.

6866. The London beers have not been found to have arsenic?—That accounts for it, but at the same time as I have shown you even in anthracite there is more arsenic than will now be passed, and it can be removed in the same way as the arsenic from worse fuel, viz., by brushing and polishing the malt.

Arsenic in anthracite,

6867. I suppose that care taken in the selection of the coal would almost do it?—I do not think you will find any anthracite quite free from arsenic. What I examined was about the minimum you will find; it was a very good anthracite indeed. There is always a little pyrites, and it comes from the pyrites. Of course, we are now much more critical than we should have been before.

6868. Is it not the case that gas coke is apt to give a disagreeable flavour to the malt, so that you cannot use a very large quantity of it?—I am told that the public will have the fuel dried malt, and will not have beer made from malt dried by hot air and not by fuel, either coke or anthracite. That is what brewers and maltsters alike tell me.

6869. It has been given in evidence before us that if you use gas coke exclusively for your fire below the malt, it gives a disagreeable flavour, and that you cannot very well use pure gas coke?—I hope that is true, but I have not come across that fact.

6870. That might account for a very variable amount, according to the proportion of gas coke which was mixed with oven coke?—Certainly.

6871. You would agree with the evidence given before us that oven coke is less likely to contain arsenic than gas coke?—Yes, the figures I gave you were for oven coke, and they were from a very special quality of oven coke, that is limited in quantity and used only by the best maltsters, but even there there is a trace of arsenic which requires to be brushed off. I insist upon brushing now, and the maltsters are rapidly adopting the brushing process.

And in coke.

6872. I think I understood you to say in one specimen of malt you examined there was 1-12th of a grain per pound before brushing, and that after brushing thoroughly there was only 1-80th of a grain per pound?—Yes; after the third brushing there was 1-80th of a grain.

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6873. That points to the fact that screening and brushing, if carried out thoroughly, will almost entirely remove the contamination of arsenic?—Quite so. Screening alone is not enough, but screening and brushing is enough.

Need for official standard as regards arsenic in beer

6874. You say here that it is absolutely essential, as I suppose we should all agree, that the Legislature should provide some simple and efficient means of fixing the standard of arsenic and other things, and unless that is done there will be a great deal of useless litigation and want of uniformity. For practical purposes, what quantity of beer do you think should be taken for examination?—I ask now for a Winchester half-gallon, and I like to employ for the quantitative process a litre and a half, that is about one third of a gallon.

6875. So that a Winchester half-gallon gives you about 4½ to 5 litres?—It is over 2 litres.

6876. A sample has to be divided into three parts, so that a larger quantity would be required?—They now ask for a gallon and a half, but where they cannot well get that for various reasons, they take a gallon, and we can do with the gallon. One part goes to the vendor, one is retained by the inspector for production in Court, and one comes to the analyst, and from that one-third of a gallon I can do all that is necessary, but with the smaller quantities of arsenic I like more if I can get it.

Quantity of beer requir for purpose of F. and Acts.

6877. Do you think that is sufficient almost for practical purposes?—Half a gallon is ample for practical purposes.

6878. (*Chairman.*) Do you evaporate it down?—For the quantitative analysis I evaporate it down to a quarter of a litre, 250 cc. or thereabouts. That is the concentration of from four to six parts. For the Reinsch's test it is far better not to evaporate at all, and to take a smaller quantity, because in that way you get a more delicate distinction between a small and a large proportion of arsenic in the beer. Moreover, it is objectionable, on the whole, to take the 200 cc. that the Brewers' Committee advised; it is undesirable for the administration of the Act to take that quantity. It is far better to take 50, because every particle of the beer must come in contact with the copper. The copper does not extract arsenic from a portion of the beer a little distance away from it. It must be in contact. There is no attraction like the magnet for iron. It takes far longer, and there is more chance of underestimating if you have a larger quantity of the beer. Their method was employed for their purposes, because they wanted to fail to find a small quantity, which would be passed as not worth bothering about. But the public analyst ought to be more precise than that.

Degree of delicacy of Expert Committee's te

Reinsch te in water or beer compared.

6879. (*Sir William Church.*) I should like to know your opinion of what has been stated before us by some witnesses that the Reinsch test acts better in beer than it does in water, that is, that the arsenic is deposited more rapidly on the copper in a solution of beer than it is in water?—I do not find that. I can believe that the arsenic may begin to be deposited earlier in the beer in some circumstances, but the later portions of it will not be deposited so quickly, and probably will not be deposited at all. You fail probably to find the whole. Certainly it does not come down so well at the finish.

6880. (*Chairman.*) In respect to the quantity used, surely the Reinsch test would not lose any sensibility by using double or treble quantities of the beer boiled?—It is apt to do so if you do not boil sufficiently long.

Quantity o beer neede for Reinsc test.

6881. I think your answer confounds two distinct ideas. One is getting all the arsenic out of the beer, and another is getting as much as the beer can show on the copper. If you take a gallon of beer and boil it according to the Reinsch with a piece of copper of a given size, you would get rather more on the copper than if you only take 50cc.?—Yes, but you do not want to get so much as that.

6882. You want the test to be as sensitive as possible?—If you get a large quantity which is a small fraction of the whole, from a large quantity of beer, that is not so good a result as getting nearly the whole of the arsenic from a smaller quantity of beer.

6883. Then for that purpose the test should be continued, a first piece of copper and a second?—Yes, and

a third, fourth, and fifth, until you have exhausted the arsenic in the beer.

6884. If that is done there is reason for the smaller quantity?—If that is done the larger quantity will be no disadvantage, but when to save time you do not do that, the smaller quantity is better.

6885. If you are not going to take all the arsenic out of the beer by the Reinsch test, then the larger the quantity of beer used the better?—Yes.

6886. So that it would be better to use 100cc. than 20?—Yes, but not if you are going to make it an approximately quantitative process. If you are going to guess the quantity it is better to take the small quantity.

6887. That is to say if you continue it until you take it all out of the beer?—That is what I meant.

6888. But then, on the other hand, the quantities you get out will be too small to be perceptible. If you want to make a really exhaustive test you should take a large quantity and continue it. Every part of the beer comes in contact with the copper?—Yes, but I can find a real 1-100th of a grain per gallon by 50cc., and that is delicate enough.

6889-90. I am simply questioning the idea that under any circumstances a smaller quantity is more favourable for the Reinsch test?—I do not wish to press it. I prefer 50 now, having worked with 200 for two or three months. I prefer the 50 as the result of experience, when I wish an approximately quantitative result, not otherwise.

6891. Do you know what others use?—200.

6892. Others do use the larger quantity?—Yes, and I have come by experience to prefer the 50; the reason being this, that we get more certainly the whole of the quantity out, and a man who is in a little hurry and does not take a second piece of copper will miss some of the arsenic in the 200, and I will get the whole from 50, and the whole from 50 is better than a fraction from 200.

6893. But nobody, as a rule, continues the test until he has secured that the whole is out?—I think he ought to.

6894. That is an important point, but it is not done according to the rule that has been given as having been resolved upon by the experts who reported for the brewers?—I know, but they did not wish to find very small quantities. That is why I mentioned it here, and I think it is important, because the whole value of the test beyond their particular object is getting as nearly as possible the whole out of a certain fixed quantity of the beer. We do not want to get a large, but unknown, fraction of the whole, but as nearly as possible the whole.

6895. Then, I understand and see the rightness of your view. When you get, too, such small quantities that there is a great difficulty in weighing them, then clearly a larger quantity of the material gives you a surer result?—Yes, but for my weighing process I do not use Reinsch at all. For my weighing process I use the extraction by Fresenius method destroying the organic matter, and for that purpose I want as large a quantity as possible.

6896. (*Dr. Whitelegge.*) You found selenium in Nicholson's acid?—Yes, in all the samples I found it.

6897. Did you notice anything peculiar about the colour that suggested selenium?—No.

6898. It is not necessary then for a characteristic colour to be assumed when selenium is present?—No, because the selenium is there as selenious acid, and that is not coloured. It is selenium element that is coloured, or the sulphide. I am glad you mention that, because I have brought up an interesting specimen of selenium. (*Specimen shown.*) That is a specimen of selenium got at the Glover tower.

6899. (*Sir William Church.*) Is this from Bostock's acid?—No, that is from a good works. I did not know before that selenium was got at the Glover towers, but I am told it is skimmed off the acid.

6900. (*Dr. Whitelegge.*) As an ordinary source of selenium?—No, it is not yet utilised, I believe. It is elementary selenium.

6901. As a fruitful source of selenium?—It varies with different ores. It is not found in the flues of some works. I have always failed to get any in the flues, but it is got in the Glover towers. As the fumes go up in the presence of plenty of sulphur di-oxide, the sulphur di-oxide reduces any selenious acid to the elementary form, and the dilute acid coming down washes that solid selenium out, and it floats on the acid at the bottom. A little is also got in the chambers, but much less than at the towers.

6902. Then one would expect to find selenium ordinarily in sulphuric acid unless it has been removed by purification?—In some sulphuric acid, not in all. The acid is spontaneously purified by the sulphur di-oxide in the Glover tower, and the process of purification is merely perfecting in another tower what has been already begun.

6903. And the purification intended to remove arsenic would at the same time remove any remaining selenium?—There are several methods of removing arsenic, but the best one will also remove selenium.

6904. What method is that?—Treatment with sulphuretted hydrogen in a tower, like the Gay-Lussac tower.

6905. That removes the selenium?—Yes.

6905. Have you any reason to think that analytic results from the same barrel of beer may be affected by whether a sample was taken from the upper or the lower part?—You are thinking of a piece of evidence that was given by some other analyst to Dr. Sergeant, and I cannot go so far as he did. But there is this foundation for it that I have found very clearly, that there is relatively much less arsenic in cases of slight contamination, after the beer has been racked and the finings added than there is in the original vat in which it has been brewed. The quantity is less when the beer is finished. I have traced that to the small quantities of solid matter, finings, yeast, and other things that are more highly arsenicated than the liquid. I have come upon the further fact two or three times, that that same beer which was better after it was racked than when it was in the vat has apparently lost almost the whole of its arsenic some weeks afterwards when it has been sold in the public-house—I chanced to follow the same beer—and I can only attribute that change to the settlement of minute solid particles of the yeast, malt, and finings. They throw a handful of hops into the barrel, and when that settles it takes a little out. When the quantity of arsenic is large I have found the arsenic in the hops and sediment, but I could not make out that it was greater in the solid matter than in the liquid, and therefore did not sensibly purify the beer. No doubt it is a means of purification, when the quantity is sufficiently small, and that is partly how I account for malt slightly arsenicated yielding absolutely free beer.

6907. (*Chairman.*) Is there not a danger in the casks? Will not it go on depositing until there is a considerable quantity in the casks?—Every cask that goes back to the brewery is carefully purified by water, soda and steam successively, and there is not a trace of arsenic left after these processes. I have tried that. I have a sample I should have put in before, when speaking of Bostock's acid. A quantity of liquid sulphuric acid equal to the total liquid in that bottle yielded the amount of arsenious sulphide which is in that bottle. (*Specimen shown.*)

6908. What is the liquid?—It is water, but it shows the bulk of the 11 grammes of acid that I took, and the precipitate there is the sulphide of arsenic obtained from it.

6909. This selenium I see is marked as being from the Glover tower?—Yes.

6910. Where was it found?—It was skimmed off the acid at the bottom of the tower.

6911. Skimmed as the scum off the acid?—Yes. Bostock's acid we believe to be the acid from the bottom of the Glover tower. That is the selenium skimmed off similar acid from another works.

6912. In these other works, did that selenium get into the acid in large quantities?—It could not be perceived. I failed to find it.

6913. Although it existed in that scum to skim it off, there was not enough in the acid to show at all?—The sulphur di-oxide in the Glover tower precipitates it all as elementary selenium, and it is skimmed off in that form, and never goes out. Besides, nobody ought to sell Glover tower acid.

6914. What is done with the Glover tower acid?—It is used up again for other purposes of purification.

6915. (*Dr. Whitelegge.*) You told us just now of the divergent results obtained in the analysis of one par-

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Purification of sulphuric acid from arsenic will also remove selenium.

Beer may lose arsenic on keeping

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ticular sample; that you obtained 1-9th, and Dr. Stevenson something which, after allowance, came to 1-7th, and other results were widely different?—Mr. Jones also got 1-7th.

6916. And Somerset House only found 1-100th?—Yes.

6917. Do you regard those results as satisfactory for the purpose of a court of justice?—They are unsatisfactory, but I think there would have been a conviction; my dishes would have persuaded the magistrate, I believe.

6918. But as a matter of fact, different methods were adopted, and they led to divergent results, which divergent results would have been before the court who had to decide?—They would have been before the court.

Destruction of organic matter should be essential to any official test for arsenic in beer.

6919. In the light of that experience and others of the same kind, would you say there ought to be some agreement as to the uniform method of analysis?—To a certain extent there ought to be an agreement, and I should be perfectly satisfied with the destruction of the organic matter before starting the process of estimating and an absolute weighing of the arsenic in some form.

6920. You would be in favour of as much uniformity as possible, but you regard the preliminary destruction of the organic matter as essential in any satisfactory method?—Yes; there are two or three methods after that, and I would be content with any of them. One man might be more expert with one, and another with another.

6921. You speak of some samples as showing such very minute traces as to be considered "genuine." What sort of a standard have you in mind?—I should not like to say that any beer containing less than 1-100th of a grain per gallon was other than genuine.

6922. You would return a beer containing less than 1-100th as genuine?—Yes, I think so.

6923. In an official certificate?—I think so.

6924. Would the medical officer of health or whoever receives that certificate understand from that that it was absolutely free?—None of the medical officers that I have to do with would, because I have told them it does not always mean that.

6925. I think one of them drew the conclusion that it was entirely free. When you use the term genuine, you do not mean it to be inferred it is entirely free from arsenic?—I mean that it is practically free.

6926. You have a reservation; you do not mean absolutely free?—No; there is no beer in which I could not get a couple of crystals if I evaporated down a sufficient number of gallons.

No public analyst advises as to selection of samples under F. and D. Acts.

6927. Did you advise the authorities by whom the samples are taken as to the selection of samples and the quantity of samples?—Yes, sometimes; it is my duty to advise them.

6928. The Corporation of Liverpool and the county authority of Lancashire?—Yes; but they are not obliged to follow my advice.

6929. You are consulted?—Yes. When I was first appointed, 23½ years ago, the Corporation of Liverpool through the Health Committee told me to advise and instruct the inspectors, and that is still my duty, but since Dr. Hope became Chief Inspector—when he was made Medical Officer of Health he was made Chief Inspector—he has required much less advice.

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6930. But you do confer with Dr. Hope?—Yes, by telephone nearly every day. The county authorities, when they appointed me in 1875, also clearly instructed me to advise the superintendents, and particularly to tell them in each case, whether the certificate was such as to indicate clearly an offence or not. That is still my duty.

6931. If you became aware of any danger to public health arising out of such a matter as arsenic in beer it would rest with you to advise that samples be taken?—It would not be my official duty to do it, but I should be expected to do it, and I should certainly do it.

Analyst has no instructions from Local Government Board,

6932. Have you received instructions from the Local Government Board of any kind?—Not from the Local Government Board.

6933. You make an annual and quarterly report to the Local Government Board?—I make a statutory quarterly report to every authority for which I act, and a copy of that has to be made out by their office and sent to the Local Government Board.

6934. So that you have no official communication with the Local Government Board?—Not directly. But they send me a copy of their annual reports, and get copies of my quarterly reports.

and not in relation with Government Laboratory.

6935. Are you in official relation with the Government laboratory?—No.

6936. And neither from the Government laboratory nor the Local Government Board have you received any official instructions?—No. I should prefer not to receive instructions from them. We have had private communications, and comparing of notes occasionally for mutual benefit, which has been very useful. There are a number of details in the reports that have been handed to you by Dr. Sergeant and Dr. Hope which are not quite correct, partly through clerical errors, no doubt, and partly because my first returns were made upon the very rough qualitative estimation not intended to be for the purposes of the Act; "a small quantity," and that sort of phrase was used. It was after the first quarterly report, before I had better estimates, and therefore the medical officers have not in all cases got the better estimates. I have prepared clear details of the whole for the different authorities, which you might like to have, and which may be more reliable than what you received from them. (*Document handed in.*)

6937. (*Sir William Church.*) Shall we be able to identify these with the tables we have already got?—I think so. I have put them in such a form as would do that. In addition, there is the Borough of Preston, which they do not know about; there is the Borough of Blackburn, for which Mr. Collingwood Williams acts; and there is the Borough of Barrow-in-Furness, for which he also acts. The Borough of Bootle, for which we both act, had all its beers so purified by the action of the city authorities that they never found any arsenical beer. (*Documents put in.*)

6938. (*Chairman.*) I understand you have some suggestions to make to us as to administrative questions, which you will send to Dr. Buchanan for incorporation as an Appendix?—Yes. (*See Appendix No.* 15, p. 362.)

FOURTEENTH DAY.

AT WESTMINSTER PALACE HOTEL.

Saturday, 4th May, 1901.

PRESENT:

The Right Hon. LORD KELVIN (*Chairman*).

Sir WILLIAM CHURCH.
The Right Hon. Sir WILLIAM HART-DYKE.
Dr. WHITELEGGE.
Mr. COSMO BONSOR.

Dr. BUCHANAN, *Secretary*.

Mr. THOMAS WATSON LOVIBOND; called and Examined.

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6939. (*Chairman.*) You have held the position of managing director to the Newcastle Breweries for 11 or 12 years?—Yes.

6940. Is that a large trade?—Yes, a very large business; involving nearly two millions of money and two hundred thousand barrels a year turnover.

6941. You were chairman during two years, 1899 and 1900, of the Country Brewers' Society?—Yes, I vacated the chair in December last.

6942. And you are Fellow of the Institute of Chemistry, and worked formerly under Dr. Graham in University College, London?—Yes.

6943. You have practised and supervised in brewing operations for thirty-eight years, and are acquainted with the manufacture of every class of beer?—Yes.

6944. I understand, with the great experience you have thus had, you wish to endorse what has been told us about the desirability of using sugars and other adjuncts in brewing?—Fully; I look upon them as a practical necessity for modern brewing—an absolute necessity.

6945. Is it your opinion that these adjuncts are an advantage to the brewer?—If the adjuncts are properly chosen they improve the quality of the beer, and in some cases effect economy, but not so much in all cases.

6946. But you consider they improve the quality?—If they are properly chosen—decidedly.

6947. An incidental advantage is the shortening of the time needed to brew?—That is my own experience. I have been able at Newcastle to turn out good light beers in very much less time than was the custom of the trade formerly, under a fortnight a great deal of our beers, and three weeks the longest, and of course the advantages to me are considerable. I have been able to make a cellarage accommodation serve now for three times the trade it served for twelve years ago.

6948. In your view and the view of your Society, if adjuncts were prohibited, more foreign barley would have to be used?—Unquestionably. Foreign barley is the one substitute that we can look to in the absence of what are commonly called adjuncts. English barley, except the very finest, is not fitted for use entirely by itself.

6949. The British barley grower, we understand in your view, would not benefit by the prohibition of brewing sugars?—I do not think he would.

6950. Speaking on behalf of the trade, you would welcome any recommendation which would safeguard the public against any possible contamination of beer—for instance, by arsenic?—Certainly I would—any recommendation which would safeguard the public would protect the brewer as well.

6951. Whether introduced in the malt or by brewing sugars?—Wherever it comes from, if it can be safeguarded it will be a protection to us as well as to the public.

6952. Can you tell us how many brewers there are in England and Wales apart from publican brewers?—I cannot give you any figures later than September, 1899, and in that year there were about 6,796 brewers altogether, and a large proportion of those, very nearly 5,000, were practically publican brewers; so that the brewers of any importance were only some 1,800. Of those 300 are small, the general result being that there are only some 1,400 brewers of any importance.

Many brewers use no adjuncts to malt, but their output is small.

6953. Brewers other than publicans?—Yes, in England, and of those very nearly half are members of our Society. My reason for wishing to state this is that statements are being constantly made, and Mr. Chaplin himself in the House made a similar statement, to the effect that the great majority of the brewing trade do not use adjuncts, and that, of course, was intended to convey the impression that the use of adjuncts is in the minority in quantity, whereas it is only in the minority in number of brewers. The 5,000 publican brewers, who, of course, are a very large proportion in number, only use 3·8 per cent. of the total brewing materials used in the Kingdom. They are a perfectly insignificant minority, and do not in any way represent the brewing trade.

6954. Do the publican brewers use brewing sugars?—To a very small extent.

6955. (*Mr. Cosmo Bonsor.*) Those are the Excise statistics?—Yes. I have put in fuller papers in sending my proof to Dr. Buchanan, but they are public figures. There is nothing at all that cannot be got at in the ordinary way.

6956. (*Chairman.*) How many brewers to your knowledge use no malt adjuncts?—I could not say that. You may safely take it that a great proportion of publican brewers, the small brewers, use none, but of the balance, the important brewers, I should say there are very few indeed who use none, but I could not give you figures.

6957. Are any of the publican brewers members of the Country Brewers' Society?—No, they would scarcely be eligible. The Country Brewers' Society is supposed to represent the wholesale brewing trade of the country, not including Burton or London, and one or two other important districts, such as Manchester, where they have their own large and important societies, independent of the Country Brewers'.

Action by Country Brewers' Society on discovery of arsenic in beer.

6958. Can you give us a statement of the action taken by the Country Brewers' Society with regard to arsenic in beer since November 24th, 1900?—Yes. I give that statement with a view to showing that the Country Brewers' Society was as active as possible in facing this difficulty, and in warning its members of the danger that had arisen very unexpectedly. The first intimation was on the 24th November, when I saw two paragraphs in the North Country papers to the effect that there had been arsenical poisoning on the western side of the Northern part of England. I sent those paragraphs at once to the secretary. At that time I was chairman. The secretary, on the 28th November, interviewed a reporter from the "Daily Telegraph," and on the same day a meeting of the Parliamentary Committee of the Society was held, and on the following day, the 29th November, a letter from the secretary appeared in the "Times," asking the public to

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suspend their judgment until the facts were better known. On the same day a circular was issued to the members of the Society, warning them that no sugars should be used in brewing unless they had been examined for arsenic. That circular is, I believe, the first circular of any public nature which was issued to any large number of the brewing trade on this subject. I believe that it was issued simultaneously with Messrs. Bostock's telegram to their own customers, but it was issued prior to Messrs. Bostock's circular in which they explained more fully, and asked that their materials should not be used. On the 30th another meeting of the Parliamentary Committee was held, and another paragraph was issued intended to allay alarm. On the 3rd December the matter was considered by the General Committee of the Society, and the steps taken up to that time by the Parliamentary Committee were approved. On the 13th December the General Committee met again, received a further report from the scientific advisers, and ordered that another circular, marked "C," advising examination for arsenic of all descriptions of glucoses, invert sugars, priming sugars, and caramels, and urging that facilities should be given to local authorities, should be sent to the members. On the 19th December a circular, marked "D," was issued to the members of the Society, quoting Mr. Estcourt's warning as to the presence of arsenic in malt, and again advising care. On the 21st December copies of the report (marked "E" in my papers) of the Commission of Experts appointed by the Manchester Brewers' Association (*Appendix* 5), and of Dr. Dr. Dupré's letter to the "Times" of December 21st, were issued to the members of the Society. On the 9th January, 1901, the Parliamentary Committee met and again discussed the matter. On the 25th January, at a meeting of the General Committee, the advisers reported additional facts, and certain points were referred to the General Purposes Sub-Committee for inquiry. On the 7th February the General Purposes Sub-Committee met. On the 15th February they again met, and the General Committee met and received a report from the Sub-Committee, and the further circular, marked "G," dated February 15th, asking for particulars of any proceedings which were being threatened against members, was issued to the members. We have also distributed Dr. Buchanan's report to the Local Government Board. Extracts have been issued to all members.

6959. The Society kept a close watch on the developments of the subject?—I think you may take that—probably the closest of any public body connected with the trade.

6960. Who are the scientific advisers of the Society?—Dr. Moritz and Dr. Morris.

6961. Dr. Buchanan informs us that he was in error in saying in a foot-note to his report to the Local Government Board that a circular sent to the members of the Country Brewers' Society cautioned them against Bostock's sugar, the fact really being that members were cautioned against the use of any brewing sugars which had not been first examined for arsenic, and that he would like this put right?—Yes. Our first circular was issued on the 29th November, and it did not mention Messrs. Bostock's name. At that time Messrs. Bostock's name was scarcely public property, and we did not desire to mention any firm by name. But we did issue that circular six days before the issue of the Manchester expert's report.

6962. Dr. Buchanan states that he has informed the Brewers' Society that this would be corrected in any further issue of his report?—I shall be very much obliged. We should be glad that this slight inaccuracy in the report should be corrected so as to set the Society quite straight before this Commission and before the public generally.

Action by Newcastle Brewery Company.

6963. In respect to action taken with regard to arsenic by your own firm?—I think on that subject I had better perhaps tell you exactly what I have done. As soon as our fears were aroused by the knowledge of what was taking place elsewhere, I had analyses made in my own laboratory by our head brewer, who himself is a perfectly competent chemist, for arsenic of all our materials and all our products—very carefully done indeed; and the result was that we found no arsenic whatever existing in any one of these materials or products excepting in one instance. In that instance the amount of arsenic found was definitely perceptible, but it was exceedingly small; it would not be more than 1-20th of a milligramme of arsenic in 5 grammes of the dust.

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No arsenic found in malt culms.

6964. (*Sir William Hart Dyke.*) Malt dust?—Yes, but I must explain what kind of dust. The substance in which we found this minute trace of arsenic was not the malt culms—or combings as they are called in some parts—that is to say the rootlets of the growing barley. In that we found none, but the dust in which we did find a trace was the very fine dust which is rubbed off the malt, and which is exhausted from the malt before grinding by means of a fan, and carried to a chamber. In 5 grammes of that dust we found 1-20th of a milligramme of arsenic or something under. I need hardly point out that that dust is a very miscellaneous sort of substance. It is partly soil, partly spores of all kinds of organisms, and tiny bits of the skin or husk of the malt. It is a very mixed product which in our case does not go into the beer at all. It is extracted by the malt fan and removed before the malt is ground. One material of which I had my doubts was very carefully examined, and that is the coke we use for drying the malt. We do not use anthracite coal in the North of England, the freight being very heavy; it is costly. We use coke, and it has been the practice with my company to use the best oven coke we can get. It is the Mickley Coal Company's coke, and we did not find after many examinations of this coke that there was any arsenic present. It is a very high-class coke, an oven coke and not a gas coke. Gas coke is more or less a suspicious subject. It is a coke I never would have used and never have used.

Dut present in malt dus

Oven coke used in the maltings.

6965. (*Sir William Hart Dyke.*) Did you ever use gas coke?—Gas coke probably still is used in some parts of the country, but I have never used it because I know the risk and dangers of it.

6966. (*Chairman.*) Did you know the risk of arsenic in coke before this recent epidemic?—As a chemist I knew it perfectly well; as a practical brewer it had never been brought before me in such a way as to make me think it necessary to search for arsenic.

6967. The malt to which you referred as having found a very small trace of arsenic in the dust was malt made by yourselves?—Yes.

6968. Do you make all your own malt?—Not quite. We buy probably 1-5th of our consumption.

6969. Have you tested any of the malt you bought for arsenic?—Since the trouble in November last we have only bought malt from a firm in Newcastle, and their malt has been tested and found as satisfactory as our own. Their practice is the same as ours. They use a high-class oven coke for drying.

6970. Have you tried more than once to find whether there is any arsenic in the rootlets?—Yes, several times, and we have not found arsenic in the rootlets. I ought to explain that in the process of aspirating the real *bond fide* dust to which I have referred, the rootlets are left in a very much cleaner condition than they would be if the malt was screened as a whole. The screening and grinding are conducted in one operation, the small dust is aspirated out by the fan, but the malt culms are dropped through the breeze of the fan, and are gathered in a separate place, clear of the fine dust.

Screening separates malt culm and dust.

6971. Is the clearing away of the fine dust done after the rootlets have been knocked off?—After they have been knocked off, but at the same time as the whole malt, culms, dust, and everything are dropping down towards the mill.

6972. You draw away the fine dust?—Yes, by a fan.

6973. And the fan would not carry the rootlets away?—No, the rootlets go in one direction, the malt in another, and the dust in another.

6974. We understand from the statement we have before us that you can and do produce beer in which no arsenic can be detected in a half litre?—Quite so. We have attempted many of our experiments on the full half litre instead of on the 200cc. recommended by the committee of experts who reported to the Manchester brewers.

No arseni detected half a litr of their b

6975. By what test?—By the Reinsch test.

6976. How much copper have you used, and how long a time for boiling?—The quantity of copper is not essential; we use a small piece something under an inch square.

6977. Each side was coated?—There would be two sides, arsenic free copper gauze, and the time would be somewhere near an hour.

6978. Have you ever put in fresh copper and continued the boiling for another hour?—Yes; we have done that; we have carried on some of our experiments for a very long time, two or three hours with the view of seeing if that would give a different result, but we have not found arsenic.

6979. Have you found arsenic in any case?—In no case at all except in the case of this fine malt dust.

6980. In the case of the malt dust you perform the test in the same way by boiling?—No, that would not be conducted in the same way; that would be digested with nitric acid and suphuric acid, and then the product washed out and treated by the Marsh test.

6981. In the case of malt, what quantity has been found free from arsenic by Marsh or Reinsch tests?—We have taken from 5 to 10 grammes; generally 5 grammes, but some of our experiments have been done on 10.

6982. What adjuncts do you use in your brewery?—I have not used glucose for a good many years. The adjuncts I have used and am now using are inverted cane sugar and maize grits.

6983. The maize grits are converted by the aid of sulphuric acid?—No. On that point I may mention that for many years I inverted my own cane sugar by the aid of sulphuric acid. Not with any view of avoiding arsenic, but with the view to keep an exceedingly unpleasant and difficult material to handle like vitriol out of the brewery, I some years ago adopted the process of inverting the cane sugar by means of yeast, a simple and admirable process which inverts cane sugar in exactly the same way as acid, but in which the agent employed is brewers' yeast. That has been my method for some years past. In the case of the maize grits, there the conversion is the purely natural diastatic conversion in which the agent is the diastase of malt and the product made is not the glucose of sugar manufacturers, like Bostock's and others, which is mainly dextrose, but it is the natural substances always obtained in the mash tun, viz., dextrin and maltose.

6984. Does that give the same result in brewing as inverts prepared from sugar?—It is not to be compared with invert prepared from sugar, because the products are different, but it is to be compared with the glucose, mainly dextrose, made from grain such as rice or maize. But whereas the glucose manufacturer produces an article mainly dextrose, easily fermentable, the conversion by means of diastase produces a wort composed of maltose and dextrin, which are the natural substances produced by diastatic conversion of malt itself.

6985. With respect to the brewing the beer, is it nearly the same whether you take the glucose or invert made by sulphuric acid, or whether you take invert made in the manner you have described?—No, the results are widely different. In the case of grain, more particularly maize grain—I do not say quite the same of rice—but in the case of maize the results by our mode of conversion are vastly superior to the results obtained from acid made glucose.

6986. In what respect superior?—In respect of fulness of the resulting beer, and in flavour. I think those are the two main points. The beer is fuller, and the flavour is better.

6987. In respect to alcoholic result is it the same?—I should think theoretically you would get a little more alcohol from the sugar makers' glucose than you would from the corresponding quantity of grain. I think there would be a little difference inasmuch as the dextrose of the sugar maker is a more fermentable substance than the mixed sugars that are produced by the diastatic mode of conversion in the mash tun.

6988. What you call the "diastatic mode" is conversion by yeast?—No, I mean a mash tun conversion. Diastase is a soluble ferment, to use a simple expression, which is produced naturally. In barley malt that diastase has a convertive power which acts not alone on the starch and sugar materials of which the malt consists, but on all other starch or sugar materials presented to it under proper conditions, and we make use of this diastatic power. I think I ought to explain that the yeast conversion which is in your mind, and to which I referred just now, is a totally different thing. That is not a conversion of starch into malt sugars, which is the mash tun process, but a conversion of cane sugar into invert sugar which is not a mash tun process. The latter is done outside the mash tun, and there is no connection between the two processes.

6989. (*Sir William Hart Dyke.*) It is added afterwards?—Yes, the invert sugar is added in the copper after the mashing.

6990. After that process is over?—Yes.

Inversion of cane sugar by yeast.

6991. (*Chairman.*) How do you conduct the inversion of cane sugar by yeast?—It is a question of temperature. The cane sugar is first dissolved in boiling water. The hot sugar solution is cooled down to the proper temperature, the temperature of maximum invertive power or activity of the yeast, a proper proportion of yeast is added, and it is a mere question of time for the yeast to effect the complete inversion of the cane sugar into invert sugar.

6992. If that process was allowed to continue, alcoholic fermentation would take place?—No. The temperature at which it is done is not a suitable temperature for fermentation. In fact the yeast which is used for inverting the sugar is killed so far as its fermentative or alcoholic producing power is concerned.

6993. You do not first treat the yeast in any way?—No.

6994. At what temperature do you conduct this inversion process by yeast?—About 130 to 135 F.

6995. And the fermenting temperature is much lower?—Yes, from 54 to 75 F. in this country. It would not go on at the higher temperature of 130.

Preparation of maize grits.

6996. You use the word with reference to the maize, "maize grits"; how is that produced?—That is produced mainly in America by purely mechanical means. The maize grain is decorticated, and then run through machines, and attacked by means of knives, which cut out the germ of the grain, and the germ of the grain is that part which contains nearly all the oily matter of the maize, most of the albuminous matter, and practically all that portion of the albuminous matter that is soluble. The remainder is ground between rollers into pieces about the size of large pin heads. The fine starch dust which arises in the process is carefully taken out and used for other purposes, and the grits sent to us consist of nothing but the pin head size bits of the starchy matter of the grain.

6997. And contains none of the oily matter?—Practically none of the oil, and practically none of the soluble albuminoids.

6998. (*Mr. Cosmo Bonsor.*) There is no chemical used in the process?—No, it is entirely mechanical.

6999. (*Chairman.*) Does that separate entirely the germinating portion of the maize from the remainder?—Yes, it separates the germ entirely.

7000. Would it be correct to describe maize grits as starch?—A very pure form of starch indeed, considering it has not been purified by any manufacture.

7001. You get it so pure it gives no disagreeable flavours?—No, and our flavours are improved, which could not be said of many forms of raw grain.

7002. Is it by fans that the maize is separated into two parts?—I have never been through an American mill, but I should think it was rather done by screens than fans; it is bound to be done by screens. Fans would not give the clean dust-free product we require.

7003. Do you buy any of your adjuncts beside the maize grits?—That comes from America.

7004. Have you had occasion to require any guarantee with reference to the quality of the maize grits?—No, we buy by sample, and if it comes according to sample we are perfectly satisfied. From the point of view of arsenic I do not consider there is the least necessity to require a guarantee as regards maize grits. We have examined them, but we did not expect to find, and did not find any arsenic.

No arsenic found in them.

7005. Do you buy any other adjunct?—Nothing but cane sugar. That also is an article which I believe is above suspicion—unless it is treated with arsenicated acid.

7006. We are to understand then in your own brewery you have never used sulphuric acid?—Yes, some years ago, but I gave it up.

7007. And you never use it now?—No, and have not done so for some years.

Objection to use of sulphuric acid in a brewery.

7008. Did you give it up for anything deleterious, or only from inconvenience?—I gave it up because I looked upon it as a dangerous and unpleasant material to handle—a splash in the eye will deprive a man of his eyesight. I had two or three accidents; I gave it up because I found a better method.

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7009. The method you practise you found also fairly economical?—More economical than acid, because my yeast costs me nothing, and my acid did cost something, although it is a cheap substance.

7010. So that you use what you find and believe to be a safer and better process, and yet not a more costly process?—More economical, in fact.

7011. In the general way you still approve of the use of what are called brewers' sugars?—Certainly.

7012. Although you do not use them yourself?—I have no fault to find with them. Other brewers find them useful, and I know they are useful. They come under the general principle of useful adjuncts. In my opinion glucose is not so useful an adjunct as invert sugar, but that is a matter of opinion in which some brewers differ from me, and they find glucose a useful material, and it is one of that class which I consider essential materials to be used for modern brewing.

7013. You would rather not use sulphuric acid yourself, but if the users of brewers' sugar find it advantageous you do not disapprove?—Not at all, because the brewers' sugar makers remove the vitriol.

7014. And they take upon themselves the arrangements to prevent inconveniences from such a dangerous material?—Yes, and they ought to take upon themselves the risk.

7015. It must be found economical by them, and by some brewers to use sulphuric acid in that way?—Yes, it is economical, undoubtedly. The acid process is practically the only one available for manufacturers who manufacture on a very large scale. I do not think the yeast process would be practicable, or applicable to the enormous scale of the sugar manufacturer.

Tied house system facilitated withdrawal of arsenical beer from publicans.

7016. You have some remarks to make with regard to the tied house system in relation to the epidemic?—I should like to point out that much as the tied-house system may be abused, I believe that in this case it has been a very great deal of assistance throughout this trouble in the Manchester and North-Western district. If it had not been for the absolute power of control which the brewer has over his tenant and customer in the matter of his stocks and so on, instead of these beers being promptly condemned, and carted back to the brewery, and taken out of consumption, as they were throughout practically the whole of the district, the licensees would have had to be dealt with individually. You would have been dealing with a class of men ignorant to a very large extent of the risks they were running and, as has been shown in two or three isolated cases, you would have found objections and difficulties on the part of some licensees to having the beer condemned in a wholesale way. I suggest that the tied-house system enabled the large brewers, like my friend Mr. Groves' firm, to insist upon the prompt and immediate withdrawal of these beers from consumption, and their prompt destruction.

7017. (*Sir William Hart Dyke.*) You describe two systems, your own and the one more generally used, in each case making adjuncts; in your case by the use of yeast and in the other through the medium of sulphuric acid?—Yes. They only apply as I think I explained to cane sugar. They do not apply to grain conversion. As far as the results are concerned they are identical. It is a mere question of method and time.

7018. Did you adopt this method you have described so well to us, the yeast system, on account of its cheapness, or had you a hidden dread that a catastrophe might happen through the use of a material which might contain arsenic?—I looked upon it as a great advantage to get rid of a dangerous substance like vitriol. I had one or two small accidents from careless men and I did not want to have the responsibility of blinding a man or injuring a man, and I was only too glad to find a process which enabled me to achieve the same result without the use of vitriol.

7019. Apart from avoiding arsenic it was a dangerous stuff to meddle with, and you thought the other process was equally cheap and secure, and would suit you?—In the use of vitriol I was always careful to use good vitriol because I know perfectly well, as most of us do know, that the common vitriol produced for manurial manufacturing purposes, contains a great amount of arsenic, and is totally unfit for our use.

7020. You say by the use of malt adjuncts you are enabled to produce a better beer in from 2 to 3 weeks time instead of an inferior article from all malt in about double the time. I want you to tell the Commission something in regard to this newer system—it may not be called a modern system because it has been going on for a good many years—of brewing through adjuncts instead of the older system by malt. Has this system grown up on account of a change in the taste of the public?—I think you may say that since 1880 the use of malt adjuncts has created a taste for lighter, cleaner beers. The natural result of using these materials was the production of a lighter and cleaner beer that hit the public taste, and that change has been gradually going on for the last 22 years with the result that there is far more of this light clean beer brewed now than there was then, and also with the result that the heavier beers of our fathers' days are brewed far less. They are not so wholesome, there is no question about it, and to me they are not so palatable.

Light beer prepared with adjunct preferred by public.

7021. I think you rather criticised the quality of some of the home-grown barley, and I suppose you would wish the Commission to understand that in your trade, apart from the reasons you have just given for the change in the system of brewing, there have been difficulties as regards the qualities of English malt. In some years there is a great difference in English barley, and where an inferior barley is used, adjuncts have to be employed to supply the saccharine matter which is absent?—It is necessary to make some distinction between the various parts of the kingdom. Take Norfolk and Suffolk, where in ordinary good seasons very fine barleys are grown.

Variations in quality of English barley.

7022. Lincolnshire?—Some of the Lincolnshire chalk districts produce very fine barley. There are many districts which produce the very best barley England can grow, and that means as good barley as can be grown anywhere else; but there are other districts, notably my own district, Northumberland and Durham, where our barleys are coarse in nature, coarse in composition, and coarse in their skin, and where it is only in favourable years when we have a favourable harvest time without much wet and so on, that we can use our barleys to any considerable extent. This year I have only bought about a thousand quarters of local barleys; a rival of mine in the trade who is doing an almost equally large business, told his shareholders that he had bought one parcel this season and could not buy any more. Last harvest was an unfavourable one. Other harvests I buy some thousands of quarters of the local barley.

7023. Providing you could get a good sample you have no objection to any home-grown barley?—No; the quality of our malting barleys must be above a certain standard; if the barleys are below that standard it must go for grinding, it is not good enough for us.

7024. (*Chairman.*) Do you buy much foreign barley?—Yes, a great deal.

7025. You find it necessary?—Yes.

7026. (*Sir William Hart Dyke.*) You have had 38 years' experience of brewing, and having had a thorough knowledge of chemistry as well, you have been able to go very thoroughly into the causes of this late epidemic?—I think as thoroughly as any other brewer in the kingdom.

7027. As regards your examination of the malt and malt test, you only malt a certain percentage of the malt you use?—70 or 80 per cent. is made at home.

7028. And the balance of course you buy?—Yes.

7029. Will you tell the Commission where you are in the habit of purchasing your malt?—What I call our ordinary malts, that is for the manufacture of ordinary mild beers, are bought generally either from a maltster in Newcastle, a friend and neighbour of our own, or from another old friend and comparative neighbour at Berwick-on-Tweed, where the same class of barley is malted. But if we have to buy fine malts for pale ales we generally go to Newark or some other place where we can get malt made from fine Lincolnshire chalk land barleys or good Norfolk barleys.

7030. When you went through this testing process of the materials you were using, did you test the purchased malt?—At that time we were only buying from one maker, our Newcastle friend, and his malt was tested with the same result as our own.

7031. Both classes were therefore tested, home-made and that which you purchased?—Yes.

Gas coke unfit for malting.

7032. Have you ever used gas coke?—No; my knowledge tells me that gas coke is an unfit substance for the purpose. It is liable to be too sulphurous, and that of course means the danger of arsenic.

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7033. Your knowledge of chemistry gave you a wholesome dread of gas coke?—Yes.

7034. Can you tell us from what you have read, whether you would consider there was a twofold possibility of danger as regards malt in respect to the use of the fuel, and in not cleaning the malt properly?—I should not think there is any material danger from not cleaning malt properly provided that the malt has been dried with proper fuel. I look upon the exceedingly minute quantity of arsenic which I have found in our own refuse dust as so immaterial that, although we do and have for very many years taken the pains to remove this dust, I do not think that the risk of arsenical poisoning from it is at all worth consideration. That was not our reason for removing the dust. Our reason was to remove from the malt and consequently from the mash tun and the finished beer, all, or as nearly all as possible, of the spores, germs and other organisms in the suspended condition which, if they get through into the beer, would do it harm.

7035. You think the primary cause of mischief and danger lies in the fuel?—Where arsenic can be found in malt, or beer made from malt alone, I think it is quite clear that the source must be the fuel. I know of no other source of any determinable quantity.

7036. The process of cleaning is a double process, screening and brushing, and there is a fan whereby this dust is separated?—That is so.

7037. Therefore there is a double cleansing process going on at the same time?—That is so, and that is done in most large breweries more or less perfectly according to the age of their machinery. The newest machinery will be naturally the most perfect. For many years past brewers have been devoting their serious attention to the thorough cleaning of their malt before it is ground.

7038. The only trace of arsenic you were able to find was in this dust?—This refuse dust.

7039. In a brewery where this cleaning process was carried on, badly and without proper care, this separating process might not take place?—That is quite clear. In the dust we only found 1-20th milligramme in 5 grammes. I do not know what percentage the dust is in weight to the whole of the malt, but probably not 1-10th per cent., so that you have to apply a very big factor before you can bring that quantity of arsenic into relation with the malt itself or to a pint of beer.

7040. I am pressing you on this point on the question of feeding of stock. You are aware, are you not, that large quantities of what is called "malt dust" is used for feeding stock. Is this malt dust that you said in your case is carried to a chamber elsewhere, ever used for the feeding of stock?—No, there is no nutritive power in it at all. It is dirt, dust, and filth of all kinds in a dry or powder form. What is commonly called "malt dust" is not dust at all in the sense I have been using the word "malt dust." Malt dust or malt culms or malt combings is the rootlets of the growing barley which are brittle after the malt is dried and which are knocked off and separated, and we, like all other brewers, sell that for the purpose of feeding stock, sheep more particularly. That I have found to be free from arsenic as far as our brewery is concerned.

7041. Are you aware that evidence has been given before this Commission whereby a very large quantity of arsenic has been found in what a witness termed "malt dust" which had been accumulating for many months in a kiln? I suppose under no circumstances such dust as that could be used for the purpose of feeding stock?—I would not like to say it could not be used for the feeding of stock, but I should say that the malt combings which accumulate underneath the tiles would be a very poor food and very unlikely to be used for the purpose. Where arsenic has been found in these malt combings or rootlets I think you will find that that will be concurrently with the use of an inferior fuel. If an arsenical fuel is used for drying the malt you will find more arsenic in proportion in the rootlets than you will in the malt, because arsenic comes up with the products of combustion from the fire, and the arsenic is deposited upon the malt as it goes through, and it will naturally, in proportion to the weight of the substance, be deposited in larger quantity on the rootlet than upon the grain which is large and comparatively heavy.

7042. (*Mr. Cosmo Bonsor.*) I should like to ask a question with regard to the difficulties that this Commission is in on the question of different samples having been analysed for arsenic, and of different chemists giving absolutely different results. We have had extremely variable replies to the same sample, varying from 1-5th to 1-50th, and, as a practical brewer, I was going to ask you whether you would think it possible that the difference in the sample being drawn from the top of the cask or the bottom of the cask might make some difference?—No, not in the case of the beer. I should say it would make no difference.

7043. I presume you use finings?—Yes, for most of our beer.

7044. What acid do you use for dissolving the isinglass?—Sulphurous acid.

7045. Not sour beer?—No.

7046. Those finings would fall, I presume, to the bottom of the cask?—Yes.

7047. Would not they collect a certain amount of arsenic or any impurity?—They collect all mechanical impurities, of course, and I am not prepared to say that they might not collect arsenical impurity. I do not think so, because I should look for the arsenic in solution. But I am not prepared to say it does not. On that subject of the differing results from different chemists may I point out that the determination of exceedingly minute quantities of arsenic is a very delicate one. It is not one that can be reduced to terms of an ordinary balance; you cannot get it out and weigh it like you can lime or anything of that kind. And these very minute quantities are reported upon the basis of certain appearances in the Reinsch or Marsh tubes, and a good deal depends on the personal equation of the analyst. I look upon it as very desirable that there should be some kind of exposition of a standard method to be devised by a committee of the very best and most accomplished chemists connected with the higher chemistry and our trade—a standard method applicable to beer and the other substances used in our business by which the appreciable quantity of arsenic which shall be considered objectionable shall be found, and so the product or the beer condemned.

Standard method of analysis for arsenic in beer should be prescribed

7048. You would be prepared to accept one of the Government Departments to name that standard?—I should have far more confidence in a recommendation made by the Government Department in conjunction with a committee of experts outside the Department.

7049. I expect no Government Department would name a standard of that description without such a thorough scientific enquiry?—Then I would have perfect confidence in it.

after thorough investigation.

7050. What is in my mind is that you may set a standard to-day which may be absolutely and totally inapplicable ten years hence. To-day's knowledge may be varied by something which may happen, and consequently you will want some Government Department from time to time to readjust the standard if necessary?—Under these circumstances I would have every confidence in a recommendation made by the proper Government Department.

7051. (*Dr. Whitelegge.*) In issuing your circular to the members of the Country Brewers' Society on November 29th, did you suggest any particular test or standard?—No, that is not our business. I do not think the society is competent to make such a recommendation; we merely advised that they must not for their own safety use glucose and sugars without having them analysed

7052. In your own case you have examined not only the beer, but all the ingredients, and only in one case, that of malt dust, you found arsenic?—That is so.

7053. Are we to understand that all the rest were absolutely free from arsenic?—Absolutely.

7054. No trace?—No trace.

7055. Were those results confirmed by the scientific advisers of whom you spoke?—No, I did not think it necessary to send my material to London or to incur any very great expense. I am a Fellow of the Institute of Chemistry myself, and my head brewer is at least as competent a chemist as I am—I should say much more so—and we considered ourselves quite capable of doing it at home.

7056. Had Dr. Moritz and Dr. Morris been advising the society before this recent arsenic question?—Generally for years. Dr. Moritz has been our adviser for a great many years; Dr. Morris only more recently, when he joined Dr. Moritz.

7057. In the case of the malt you buy, is that brushed

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before delivery to you or after?—I should say in the case of what I buy in Newcastle it is brushed, because they have a perfectly appointed malting, and they are very smart people. What I buy in one or two places I think probably will not be brushed, but run over a screen, but I cannot say with certainty. It will depend on the enterprise and perfection with which the maltster carries out his malting process.

All malt at his brewery is brushed.

7058. If it reaches you without being brushed, would it be brushed?—Yes; whatever is done to it beforehand.

7059. In bought malt, do you make any stipulation as to the fuel to be used?—No, I have never made a stipulation.

No guarantee as to fuel demanded in case of bought malt.

7060. Is it within your knowledge what fuel is used by the maltsters from whom you buy?—No. I simply confine myself to people in whom I have confidence, whose samples come up to the mark, and of whom I have some personal knowledge.

7061. The society are prepared to accept any precautions that seem necessary in order to prevent the risk of arsenic?—Yes. I feel sure that the society and the trade as a whole would cheerfully accept any reasonable precautions that did not involve the prohibition of the reasonable substitutes we have learned to use in the last 40 years.

Guarantees of purity have only doubtful value.

7062. What sort of precautions are you thinking of—guarantees or analysis?—I do not think a guarantee is of much use. A general guarantee is practically a useless thing. A particular guarantee—that is, a guarantee with every delivery, is such a difficult and such a costly thing, that I think it would be not observed. It seems to me that the precautions that are required are to make the manufacturer of each material, whether it be beer or whether it be sugar, responsible for the quality of his substance.

7063. Make him legally responsible?—Certainly.

7064. Would you regard it as necessary for a brewer to analyse every malt he receives for arsenic in particular?—I certainly should now.

7065. Habitually and regularly?—Yes. After our experience of November, if a brewer does not take some steps to protect himself against arsenical contamination, accidental though it might be, he is not doing his duty to himself or customers.

7066. (*Sir William Hart Dyke.*) Would you have a penalty for not doing so, or would you place the penalty upon the result?—I think the state of the law itself is quite sufficient. People have been already fined very handsome sums for negligence in this respect. There is one very prominent instance in Northamptonshire and I sympathise very warmly with the result, where a board of directors and the brewer were heavily fined for not taking proper precautions.

Little demand for all-malt light beer brewed as in Germany.

7067. (*Sir William Church.*) I should like you to inform the Commission why light beers like German, Bavarian beers cannot be brewed in this country from malt and hops alone?—I am not prepared to say they cannot be; as a matter of fact, there are two or three breweries in this country where they do more or less successfully produce such beers. Tennants, of Glasgow, produce a very good laager, as do the Tottenham Brewery in London, all from malt and hops, I believe. The reason why one does not produce the light German laager beer in this country is mainly that there is no great demand for it.

7068. In Germany the use of sugar in those light beers is forbidden?—Only in certain parts of Germany. There are parts of Germany where maize is largely used, and other parts where malt alone is used. In Bavaria, I believe, the law is very strict.

7069. It is not a matter of difference in the preparation of the malt?—Do you mean the difference in the production of the character of the beer?

7070. Yes?—There is a difference in the preparation of the malt and the mode of drying, but the essential difference is in the mode of mashing or preparing the worts. They are prepared there in a totally different way to ours; the worts are boiled, and we dare not do anything of that kind, and the result is they get a more dextrinous wort than we do, which means a less fermentable wort. The result is, although they use light gravities, they get comparatively more fulness in their beer on account of using these less fermentable materials.

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German malt not exposed to fumes, has flavour unsuitable for English beer.

7071. You would not agree with another witness who told the Commission that he thought that cylinder dried malt was used for these light beers, and would not be applicable for our general brewing purposes in England?—I do not know what he meant by the expression "cylinder dried malt." The essential difference between German and English malt, as far as drying is concerned, is that the English malt is dried by the direct products of combustion of the coke or anthracite coal being passed through the kilns and through the malt, and our experience is that if we substitute for that the German system, where the products of combustion are passed through metal tubes and the heated air from those metal tubes is used as a drying medium, we do not get the same character and flavour of malt as when we use the direct products of combustion. If by cylinder dried malt he meant a process by which hot air without the products of combustion were passed through cylinders, then I say the difference is a very material one, and the hot air process is not applicable to our English malts. It has been tried many times, and dropped.

7072. So that in your opinion roasting malt, if I might use such a term, without the direct contact of the fumes, would not produce a malt suitable for brewing beer to the English taste?—No, it would not. It has been tried many times and I do not know of any instance where it has been successfully maintained.

7073. (*Chairman.*) Is it a flavour conferred by the fumes that is wanted?—Yes. It is too complicated a thing to explain. We do not know why the differences arise but we do know that we get flavour from the malt that is dried direct from coke and from coal different from that which is dried by heated air. Empyreumatic products may account for it to some extent.

7074. Would the peat-reek flavour esteemed in Scotland for whisky do for beer?—No, I do not think so. I do not know of any instance, and I do not think there is an instance where brewers' malt has been dried by means of peat, and I should like to point out that the peat-reek would be far too powerful a flavour to make it applicable. Whisky is distilled and the peat-reek in the whisky is only that portion of it which comes over in the still.

7075. Is the flavour from oven coke the same as the flavour from anthracite?—Yes, practically; they are both fairly pure forms of carbon and as long as they are sulphur-free they are practically the same thing.

7076. (*Sir William Church.*) I think I understood you to say that the main object in brushing the malt was to get rid of impurities of all sorts, but especially of the spores of organisms. Are these organisms which have survived the heating kilns? Is not malt exposed to a temperature sufficiently high to kill organisms?—The drying process is not sufficiently high in temperature to destroy those organisms which are in the stage of suspended activity. If you will take the living organism, living under moist conditions, and put him into a kiln, I think you would inevitably kill him. But if you take an organism in a dried and inactive condition, I do not suppose the heat of the kiln would destroy it. Boiling water will not always destroy it.

Malting temperature.

7077. What is the heat that malt is exposed to?—160° to 210° F. We can only get as high as 210. Some tell me they get to 220, but I have my doubts. If we get much higher than 210 we impart too much colour to the malt. The malt begins to caramellise, and we cannot get the pale colour and the delicate flavour essential to fine beers.

7078. But the malt for porter is dried at a greater temperature?—Yes, that is done at a much higher temperature direct over fires at a very high temperature indeed.

Black malt roasted without exposure to fumes.

7079. (*Chairman.*) For porter could not the process be carried on entirely in cylinders without exposing the malt at all to the fumes of the fire?—The proportion of black malt used makes it immaterial whether it is dried by the direct products of combustion or heated air; the actual process is that a malt, after being malted and grown on the floor, is dried on a kiln in the ordinary way to a fair condition of dryness, but to be converted to black malt it is taken shortly before it is required for use to revolving cylinders and there it is roasted like coffee over a glowing hot fire and almost touching.

Mr. THOMAS EARP, called; and Examined.

7080. (*Chairman.*) You are a partner in the firm of Messrs. Gilstrap and Earp, maltsters, in Newark-on-Trent?—I am.

7081. You have represented Newark-on-Trent in Parliament, I believe?—I did.

7082. You have been connected with malting for over 50 years?—Yes.

7083. During which time gas coke, oven coke, and coal have been used as fuel for drying and curing malt?—That is so.

7084. Have you found strong reason to prefer one or other of these three kinds of fuel?—Not reasons of sufficient strength to create a very great preference until the recent difficulties arose. We have also found that coal gave us less flavour which might be regarded as objectionable, less sulphur flavour, that is to say; but beyond that there has been no reason for giving it manifest preference.

7085. The coal must have been anthracite, not bituminous?—Yes.

7086. And you found anthracite preferable in respect of flavour than gas coke or oven coke?—Yes, that gave a much cleaner flavour.

7087. The difference being that there is more sulphur in the gas coke than in the oven coke?—In the gas coke especially.

7088. You tell us that you have never heard of any injury arising from the use of malt until the discovery of the effects of using glucose, that then enquiries were instituted which led to a suspicion that malt might contribute arsenic to beer, but that before this epidemic you had no suspicion malt could introduce arsenic?—That is so.

7089. Did your firm take any steps when as a result of this arsenical poisoning suspicion was directed to malt?—We instantly turned our attention to using coal exclusively. We took steps to shorten, to some extent, the period of exposure of the malt to the fumes; we endeavoured to exercise greater care in the treating of the malt on the kilns, so as to detach entirely every particle of the rootlet. We also tried the effect of brushing to some extent.

7090. Had you not done so much brushing before?—We had not; that was always left to the brewer. He was considered so far interested that our aim was to deliver the malt in a fair condition from a commercial point of view, and if brewers had special fancies for extra cleanliness we expected them to exercise their own care.

7091. You merely took the rootlets off by screening?—We merely took the rootlets off.

7092. Your firm submitted samples of malt and subsequently of cokes and coals for analysis?—We did.

7093. With what result?—I do not know whether the Commissioners would like me just to go through these particulars; I should be glad to do so.

7094. Perhaps you will kindly give us a statement of the results in respect to the analysis of malts?—I will just mention these figures and endeavour to do so in such a manner as to show how we have dealt with the difficulty. In the first place the impregnation of barley by various fuels in the process of sweating became a question with us.

7095. That is the first process?—Yes, the first process to which barley is subjected. We generally sweat it on the kiln, for 24 hours, and then after it has had time to cool, say a fortnight, we steep it, and we have always found since we established this enquiry that any impregnation which barley received, being absolutely free from any taint previously to sweating, was lost at about the sixth day of the growth of the barley on the floors. That no doubt is partly the result of the washing and sparging of the grain when it gets into steep. After the growth has gone at a temperature of from 50 to 60 and whilst the barley is yet green, say after the 4th or 5th day, we found no trace whatever of impregnation by arsenic.

7096. Did you find some impregnation of arsenic from the primary kilning?—Yes; but we consider that is lost in the process of flooring the malt.

7097. Washed out in the steeping do you mean?—Yes. Also lost in the agitation, turning and working of the barley, but, I think, most is washed off in the steeping.

7098. The next process in which there is exposure to fuel is the drying and kilning in the malting?—That is so.

7099. Did you find arsenic introduced by the kiln drying?—Yes. We find in the various coals we have used an average anthracite gave one-seventieth grain of arsenic per lb. of coal. The same coal being used for various malts, we have found an average of 1/350th of a grain of arsenic per lb. of the malt. That is by the Marsh test.

7100. (*Sir William Church.*) There would be a variation in that from 1/50th to 1/100th?—Yes, in the coal. Now I come to the oven coke, which we find to give at the rate of 1/30th of a grain per lb. of the coke. And we find that the arsenic in malt corresponds very closely with that given by coal; 1/300th as against 1/350th of a grain per lb. of malt. Hence we conclude that oven coke is not an entirely unsafe coke to use. Gas coke gave different results. In what we have tried of gas coke it has been tried in combination with coal and this combined fuel has given us 1/200th of a grain per lb. of arsenic in malt. A sample of the gas coke alone contained 1/14th grain per pound. We have practically discontinued the use of both cokes and we are relying on anthracite coal. These experiments have been made for direction in our own manufacture.

Oven coke renders malt less arsenical than gas coke

7101. (*Chairman.*) You did not find the oven coke sufficiently free from arsenic to allow you to use it with confidence?—Not so completely so as in the case of coal.

7102. And you have resolved now to use coal only?—Yes; we are using only coal.

7103. But oven coke you find compared favourably with gas coke?—Yes.

7104. Have you turned your attention to the question of extra cleaning and screening?—Yes.

7105. Are you entirely satisfied that the mischief already done is not to be entirely eradicated by any process of cleaning or screening?—When once done we do not find that by any means we can absolutely cleanse the grain.

Arsenic cannot be altogether removed by brushing &c.

7106. So that you look upon the use of any coal that contributes arsenic to the malt as involving a danger not to be overcome by any attention to the malt afterwards, such as brushing and screening?—My contention is that it is impossible to get it absolutely free, but one naturally concludes that as malt has been used from time immemorial, and apparently without danger or injury, it may be so used in the future if we only knew the exact point at which danger may come in. For that we are looking to the Commission to give us some information which may be valuable to us in endeavouring to avert any further catastrophe.

7107. (*Sir William Church.*) When you say from "time immemorial," can you tell me when charcoal ceased to be used?—A great deal of South country malt was dried with charcoal?—Charcoal has been used quite up to within 150 years ago. I spoke of malt as having been used from time immemorial, not coke.

Use of charcoal as malting fuel.

7108. I thought you were using that as an argument of the fuel being free from arsenic?—The freedom of danger has existed since the discontinuance of the use of charcoal.

7109. That is not such a very great number of years ago, at all events in many maltings?—The great bulk of the malt has been produced by means of coal and coke drying for the last 200 years anyhow. No doubt charcoal is used, and I believe that peat has been used in old days.

7110. But 200 years ago would the bulk of the malt dried in the South of England or the Midlands be dried with coke or coal?—In the South of England coal I should think mainly. The nearer you come to the coal producing country the more coal is resorted to, and the earlier it was resorted to. But after the discovery of gas and the distribution of malting throughout the country, the various maltsters naturally relied on the nearest source of supply, which was a gas works. They were in ignorance of any danger arising from the use of it, and they simply used it—in fact, no danger was discovered and no injury apparently resulted.

7111. We have had a good deal of evidence that, comparatively speaking, few maltsters used gas coke because of gas coke giving a nasty taste to the malt?—That is

Gas coke largely used.

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the objection to it, but nevertheless it has been used and no doubt is largely used.

7112. Mixed I suppose with other coke or coal?—In some cases that would be so.

7113. (*Chairman.*) You have modified to some extent the period occupied in drying and curing malt?—We have been able to do that to some extent. During the last 15 or 20 years we have been generally using four days for the drying of malt, but in olden times, when I first knew the trade at all events, we never went beyond three days. The necessity for extending the time I think was brought about by the altered character of the beer preferred, and the use of sugar I think had something also to do with it. Malt has been made rather differently in order to work with sugar where it was thought desirable to use it. We used to make a more diastastic malt than we have made of late years, and in those days the three days' drying worked very well, but when less diastastic malt had to be produced we found a great advantage in slower drying in the first part of the process. In both cases we have had to use greater heat for curing and finishing.

7114. (*Mr. Cosmo Bonsor.*) Would the slower drying process give a larger increase of bulk?—Not necessarily. The quick drying in the old days would have the effect of promoting the growth of the acrospire in consequence of the malt being put on the kiln at a rather greater heat and forced a little, and the result was you got a greater bulk of lighter malt. Malt has been made heavier since the Malt Duty days.

7115. (*Chairman.*) Why made heavier?—I think it is the result of the better processes of brewing employed. More chemical knowledge being developed, the raw material has no doubt been used with greater care and with greater economy. To do that the extract producing properties of the malt have been increased.

Experiments with coal gas in place of fuel.

7116. Have you tried some experiments in drying which might lead to some alteration in the construction of the drying kiln?—We have done that, but I am sorry to say we have lamentably failed to arrive at much advantage at present. We have tried also the effect of drying with gas, but that has been simply experimentally on a small scale.

7117. Producer gas or common gas?—Common gas. We have passed it through a burner recommended to us by Mr. Sugg; we get it as pure as possible and still we find a slight trace of arsenic, although it was but slight.

7118. As small as you have sometimes with anthracite?—Yes, quite as small as we have found with anthracite; I almost think rather smaller.

7119. So that you would consider gas a safer fuel than even anthracite coal in respect to arsenic?—I do not know that I could go as far as to say that, but as a matter of experiment we satisfied ourselves that we have a resource in the event of our being driven to it.

7120. Gas from different gas works made with different coals would be very different in quality?—That would be so. We are not without hope that the Mond gas which is now under examination very carefully, might possibly discover something very economical and effectual.

7121. You have not as yet had any opportunity of trying it?—No.

7122. It might be a great advantage if such gas could be supplied through a large district?—It might be of very great advantage, and we think it would. I am in correspondence with an electrician, a very old friend of mine, who is making some experiments with regard to the possibility of employing electric heat for drying, and if we had the Electric Power Companies sending heat direct from our coal pits into our kilns it would be a great triumph.

7123. Would the flavour from electric heat satisfy the customers of the brewers?—There is no reason why it should not I think.

7124. I am afraid if the flavour is wanted from the fumes of coal it would not be found there when electric heat is used?—We have brewing friends who contend that that flavour is not wanted. They are satisfied with a brewing material free from that.

Experimental malting without access of fumes to grains.

7125. Have you yourself made any trials or otherwise had experience of drying the malt without allowing the fumes to have access to it at all?—Only experimentally. I tried it in a drum on one or two occasions long before the malting drums were in practical use, but I was never satisfied with the flavour myself. One has been used to working up to a certain flavour. In fact, I have generally trusted my own palate to tell me what the flavour should be, and I think if malt had been as poisonous as some people suppose I should have been a dead man a long time ago.

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7126. Have you ever tried a hot iron floor, non-perforated, to dry the malt on?—We have not tried that on a large scale, but we have put plates down just to try the experiment, and I am inclined to think that that may be a very advisable thing to try thoroughly.

7127. That would entirely eliminate arsenic from the malt so far as the drying in the kiln is concerned?—If malt is not allowed to have contact with the fumes from the coke or coal, that no doubt would be a very excellent plan.

7128. Would there be any great expense or difficulty in altering your present malt houses so as to dry without access to the fumes?—It would not be worth any consideration at all. We should simply substitute an iron tile not perforated for a perforated tile.

7129. Would that be easily done?—Easily done.

7130. You have not tried that on a large scale?—No.

7131. That would entirely get over the difficulty, and you could take whatever fuel is cheapest?—It would no doubt necessitate a modification in the system of turning. It would create the necessity for some structural alteration. We should be obliged to have machine turning in that case, because the plates would otherwise get so hot that they would char the malt.

7132. These technical matters are of great importance, but it might be easy to get over that by proper plates and air going between them?—I am quite satisfied myself there are no difficulties which might not be got over. It will largely depend on the disposition of the public to accept any decision which this Commission arrives at, and if the decision of the Commission permits the continued recourse to practices which have prevailed so long with great care against the accident of another Bostock difficulty, then intervention would not be necessitated. But if intervention and adaptation be necessitated, I am quite satisfied the difficulty can be overcome and a suitable article for brewing from can be obtained.

7133. Does the turning to which you refer on the drying plates have any effect whatever in keeping down the temperature of the plates? Suppose the turning is not practised, then certain grains of malt would remain longer in contact with the plates, and they might be turbed, the hotter the surface, the place would become.

7134. Do you think the iron plate itself would become come charred?—The longer the malt remained undisturbed?—Yes.

7135. Is the turning done by a man walking about over it?—Yes.

7136. He walks amongst the fumes?—Yes.

7137. Can he work a great many hours doing that, or is he obliged to come away pretty quickly so as not to be injured by the fumes?—They generally open all the windows of the malt kiln when they are turning, and let in all the fresh air they can. It is a process which they carry out very rapidly. They do not often leave their work before they have done it. On a kiln of say 30 quarters, you would get two or three men; on a 60-quarter kiln perhaps four or five men. They very soon turn it over, and with the windows opened no injury appears to be sustained.

7138. I have walked over a kiln on one occasion in which anthracite coal was used, and I perceived a very decided curious acrid odour from the fuel, but that does not give an injurious flavour to the malt?—Not at all.

Fumes necessary for flavour.

7139. Do you attribute the flavour of malt to any benefit got from the fumes of the anthracite coal or the coke?—No; I think it is simply the effect of the heat and air.

7140. So that any difference between drying inside a cylinder and upon a flat floor must be due to an influence of the heat on each grain which is different according to the air it meets in one way or the other?—I think so.

7141. So that if air was driven through the cylinders it might probably have the same effect that it has at present on the ordinary malting floor with open windows?—I think it might.

7142. It seems a very important matter, and if it is comparatively simple to get rid of the admission of the fumes to the malt, the very great difficulty spoken of in respect to arsenic would be entirely done away with?—I think any direction which went so far as to be a general order on that subject would be a danger, but I think experiments should be encouraged. The circumstances of the time will bring about the experiments. We have waited until we have finished our work for the season, when there are several things we, as a firm, shall try, and no doubt our neighbours will do the same.

7143. I hope you and your fellow-workers in the same field will make good experiments. This Commission cannot determine what is the best way of drying malt, but I think after what we all know now, and nobody knew a year ago, great efforts should be made to improve the mode of drying and, if possible, to get malt with the proper flavour without any access from the fumes of the fire whatever. We are encouraged to hope that from what you have said you do not think it will be a great difficulty, and not as one of the witnesses has said, entail enormous exenditure?—The suggestion made by yourself would not be an expensive matter; I mean to try iron plates not perforated. That could be done very simply. If it had not been for the question of the weight of carrying that out we should ourselves have tried it, but we thought it would not do to load the kiln with any additional weight. It might bring damage to the men.

7144. Thin iron, $\frac{1}{8}$th or 1-16th of an inch, would not add much to the weight?—I do not think sheet iron is what we shall want. I think we shall want cast metal plates; I think they would do the work better.

7145. I might suggest an experiment on the floors after suitable modification, and if you find you can get the malt properly dried and a proper flavour in that way, the process might be extended so as to suit even the fumes of bituminous coal?—Quite so.

7146. For twenty years past you have had your own laboratory, and employed a chemist in your business?—That is so.

7147. In face of the importance of the crisis through which we have been passing, you have resorted more especially to professional chemists in London and in Manchester for tests?—Yes.

7148. And for advice independently of the work done on your premises?—Yes. That has led to the formation of our determination to stick to coal until something better, at all events, was found out. It has not carried us much beyond that.

7149. You feel public spirited enough to say that you and your brother maltsters may be relied upon to co-operate in efforts to secure any advantages arising from ascertained possibilities of improvement?—That is the feeling I believe of the whole of the trade.

7150. (*Sir William Hart Dyke.*) With regard to this question of the non-perforated floor, I suppose it has not been really tried on a large scale, or sufficiently tried by maltsters for you to be able to form a very decided opinion?—No. I will tell you what has happened in a particular case. We had a little old kiln at one time with a quaint old-fashioned cast-iron tile, with slits instead of round perforations, and in process of time when it came into our possession we found that it had been somewhat neglected, and the little slits were all filled up with the broken corn and so on. I saw the heap of malt that was made in the kiln, and I was astonished at the excellence of it. It was made from very nice barley. Undoubtedly it had been practically like an iron floor, because the interstices had been closed up by neglect. Some old maltster had worked it for a time, and the turning of the grain was perpetually cutting certain corns, and the farina in a soft state had worked into the interstices.

7151. (*Mr. Cosmo Bonsor.*) No draught went through it?—Very little, indeed; and very decent malt was made.

7152. (*Chairman.*) That malt that you say was so good was made without any access to the fumes?—Yes, by accident, and it convinced me there was a possibility of making good malt in that way.

7153. You are sure the fumes had no access to that malt?—I would not say they had literally no access, but I mean to say there would be hardly any.

7154. And the malt was certainly good?—Yes, it was good. We have of course been going quite in the opposite direction lately, in that we have been getting very expensive floors, German wire floors. I have no doubt Mr. Bonsor knows all about them, and their cost. They consist of wide of triangular shape, and the upper side of the triangle is the floor, and there is an admission of the air very freely from below where the angle exists. The floors are very open, indeed. When you are underneath them and the malt is off, the light is hardly impeded; they are so very open. We have been working in that direction entirely under the belief that it was a very great advantage; if we had suspected arsenic would show itself we might have gone less in that direction.

Recently constructed malt floors very pervious.

7155. (*Mr. Cosmo Bonsor.*) You have always considered that draught is necessary?—Very much draught.

7156. (*Sir William Hart-Dyke.*) From below?—Yes.

7157. It is the same with hop drying?—Everything has been made conducive to that in all our schemes.

7158. The plan just suggested would be a direct reversal?—Direct reversal.

7159. You have not really had a proof of what the effect on the malting would be beyond this one instance you know of where it was a partial stopping?—No.

7160. It was not complete?—No.

7161. You are aware the heat would get through in a different way through these little cracks that were stopped up than through sheet iron a quarter of an inch thick; the process would be almost revolutionising the system where you have had a thorough draught from below?—Yes. The hot air would be excluded.

7162. (*Chairman.*) The fact that good malt was made in the case of the happy accident to which you refer, might perhaps point to as good a result as that happy accident which led to the invention of roast pig?—Yes.

7163. On the other hand if air must go through the malt in a way it would not do if it was placed in an unperforated floor might not a double floor be used, one a continuous iron plate, or possible tile plate to take the heat of the fire, and a well perforated floor such as that you have described for the grain to lie upon, a few inches above it, so that there would be ample circulation of hot air from below through the grating and iron cloth on which the malt rests?—I think it would be quite well worth trying.

7164. The main thing is to try whether or not the chemicals in the fumes are wanted, or whether hot air properly circulated through the malt on a flat perforated floor would suffice without the chemicals of the fumes?—Quite so.

7165. It would be a very different thing from turning it in cylinders, which I understand is the only process hitherto employed for drying the malts without access to the fumes?—That is so; I know of none other.

7166. I believe I have been told that some of the fine German lager beers are made from malts which have been dried in cylinders, without access to the fumes, I do not know whether that is correct?—I believe that is correct, but it is a different class of beer. Its treatment and methods of fermentation are different altogether. I do not know whether the difference in the beer might not be accounted for in that way. It is not the beer, I think, that the Englishman would care for.

7167. (*Sir William Hart Dyke.*) It is quite evident, is it not, that experiments in all directions will now be made, apart altogether from what this Commission may precisely seek to have adopted; you and others in your trade will be using all your experience in every direction to try and get security?—We have been doing it all our lives in one direction or another.

Maltsters endeavouring to improve their methods *qué* arsenic.

7168. You have been also cleaning your malt more than you have done previously, and it is assisting your customers?—Yes, we have done a good deal of that.

7169. As regards the purity and the protection of the public, those who drink beer, you would wish the liability to rest on the seller of the finished product?—There is no getting away from that, I think.

Responsibility for purity should rest with brewer.

7170. You think that would be just and right?—Yes.

7171. You state here you considered you have reached a position in your manufacture which gives practical purity. With regard to that I suppose the security you consider to be behind you in that regard is really the fuel?—Yes. The employment of coal and the shortening of time. The three points are the adoption of coal, the slight shortening of the time of exposure,

Ways in which arsenic in malt is being reduced.

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and the extra treating and screening keeping it clear of rootlets.

7172. You wish us to infer, do you not, that the real protection is good fuel, anthracite coal, because I think you have said in your evidence that it is impossible, take what care you may, and use what you may, to get all the arsenic out of malt when it has been conveyed there by fumes?—That is so.

Importance of malting with anthracite.

7173. Therefore your real security is the fuel?—That is our sheet anchor now.

7174. And that is the use of anthracite coal?—Yes.

7175. (*Mr. Cosmo Bonsor.*) You used to dry on tiles, I think?—We did largely.

7176. (*Chairman.*) Perforated tiles?—Yes, earthenware tiles.

7177. (*Mr. Cosmo Bonsor.*) You discontinued the earthenware tiles because the holes got blocked up and you did not get sufficient draught?—They were much more liable to block.

7178. And you did not get sufficient draught through your places?—That is so.

7179. You took the wire flooring from your kilns practically after the Ware system, and the idea of the Ware system of kiln was to get as near as possible to a chimney as could be devised?—That is so.

7180. And that is practically the kind of kiln you have at the present moment?—Yes.

7181. Consequently it would be more or less of a retrograde movement to go back to anything in the form of a closed chamber?—It would be that, undoubtedly, so far as pre-conceived ideas are concerned. The only question is as to whether the new conditions and new requirements do not necessitate even what appears to be a retrograde movement sometimes. We may have departed from the right whilst thinking we were going away from the wrong.

7182. I presume that the experiments you have had on your malt show that it is practically free from arsenic at the present moment?—Practically, at present, free. We have no complaint from day to day, and, moreover, there is a cessation of all the excitements and the deaths. If we had never had the Bostock misfortune I should not have the honour of appearing before the Commission at this moment.

Official standard of purity of malt is needed.

7183. You would be prepared, I presume, to give to the brewer a guarantee of practical purity—I do not say absolute purity?—Yes, practical purity—we are giving that.

7184. And you would be prepared to accept a standard of what is practical purity from one of the large Government Departments?—That is what we very much require. Nothing would please the trade generally more than to know what is expected of them, and what they may safely do, and I am sure they will do it.

7185. (*Dr. Whitelegge.*) Can you tell us the exact terms of the certificate which you give of practical purity from arsenic?—I am afraid I could not remember. We have not adopted one particular formula. We have varied it according to the exigencies of the case and the exactions of our friends. Some are content with simply a very thin guarantee; others are very exacting, and want something very safe. We have generally gone on these lines, and we have found it pretty generally accepted too, that we will guarantee that no malt shall leave our premises without our being satisfied that it is practically free from impurity.

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Guarantees of malt vary in form to suit customers.

7186. In speaking of arsenic derived from coal, you gave us figures showing arsenic in malt to the extent of 1-400th, 1-500th, and 1-350th?—Yes.

7187. Would you be prepared to give the certificate of the sort you named in connection with the samples containing, say, 1-300th?—Specifying?

7188. No; according to the examples you gave us, malt, in the preparation of which coal has been used, may contain 1-400th or 1-300th. Would you regard that as a sample of malt to which a certificate in the general terms you described would be appropriate?—Yes.

7189. You would not expect the brewer to understand your certificate to mean that there was not a trace of arsenic, even 1-300th of a grain to the lb.?—No, we should not expect that. There are so many uncertainties and there are so many difficulties even with regard to the purity of the particular material used in making the tests.

Brewer should brush malt, not maltster.

7190. (*Sir William Church.*) Who do you think ought to do the final brushing of the malt, the maltster or the brewer?—I hope that nothing will occur to place an obligation to do the final brushing in the malt kiln. We should want to extend our kilns very much, and we should have no end of difficulty if we had all that to do. Of course it is not an impossibility, and I fancy in some breweries there are machines which allow a certain amount of brushing to be done before the malt reaches the rollers. I think that is a safeguard to some extent, and that might be assisted by a little fan.

7191. I was not so much enquiring as to the way in which it should be done. We have had evidence before us—one brewer, if not more, said that he thought the final brushing was best done in the brewery, because they can judge better a sample of malt before it has had this final brushing than after it has. He went so far as to say that an inferior quality of malt well brushed might pass as a good sample?—I think the brewer may be trusted to find out that.

7192. You told us you had in your employment a chemist for 20 years. I presume that his business was really only to examine your materials for trade purposes. He did not examine them for accidental contaminations?—No, but in order to ascertain whether we were complying with the requirements of the chemistry of brewing.

7193. Whether your proportion of maltose was right or that sort of thing?—Quite so.

7194. You never examined for arsenic?—No.

7195. Or any other accidental impurity?—No, we never suspected anything deleterious.

Mr. Lawrence Briant, called; and Examined.

Mr. L. Briant.

7196. (*Chairman.*) You are a brewers' analyst, and have been in practice as such for 22 years?—Yes.

7197. I believe you are also the author of a book on brewing?—Yes. I am the author of a Laboratory Text Book for Brewers, which has gone through two editions, and I think I may claim to have an intimate knowledge of brewing operations and of the materials which are used therein. Since the end of November last I have examined a large number of beers and the materials with which they are brewed for the presence of arsenic, the number so examined being considerably over 2,500.

7198. I believe you have been requested by the Chemical Manufacturing Section of the Brewery Traders' Association to make enquiries on their behalf into the presence of arsenic in their manufactures, and the precautions which are taken to prevent such contaminations?—Yes, and with that object I have visited the works of the firms connected with that Association, which, whilst not including absolutely the whole of the firms which supply brewers with preservatives, etc., is certainly representative. I have made enquiries into the methods of working, and though it is obvious that in some cases special processes are employed, the details of which the manufacturer does not care to disclose, yet every facility has been afforded to me for obtaining information upon all points bearing upon the questions at issue. I have also collected from my brewery clients a number of samples of preservatives, caramels, etc., which have been supplied to them prior to the end of November last, that is to say, before the possibility of arsenical poisoning by beer was realised. So that I have examined samples both from manufacturers and supplied direct to me through brewers. These latter samples represent, therefore, the normal output of such firms prior to any alterations which might have been made in their manufacture after the discovery that arsenic had been found in beer.

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7199. What method of analysis did you adopt?—I have used the Marsh method, except at the commencement, when I used the Reinsch test. The Reinsch test, of course, is not as satisfactory in some respects as the Marsh, but it had the great advantage of being very simple and quickly performed, and at the commencement of the difficulty which occurred it was necessary to get through a large number of samples. Lately I have used the Marsh test almost exclusively. I have tried the Gutzeit test, and I have rejected it.

By the Marsh test I am able to detect with ease the presence of 01 milligramme of arsenious oxide.

7200. In how much material?—In 50 grammes of material. When I speak of substances as free from arsenic I mean that no arsenic can be found by a test of the delicacy above named when operating upon about 50 grammes of the substance under examination. The substances into which I have made a special enquiry are:—(1) Hardening materials; (2) antiseptics; (3) finings; (4) caramelised preparations; (5) yeast foods. In considering the liability of the substances which I have specially examined to introduce contamination, it is necessary to recognise the relatively small quantities which are employed by brewers. Taking the maximum amount of ingredients used in ordinary brewing operations, it will be found that with most substances used the actual quantity introduced into a gallon of beer is extremely small, so that a very gross contamination of this material would be necessary to introduce any perceptible amount of arsenic into the beer.

7201. Can you give the Commission a list of the firms or companies invited to give samples of the various materials?—I can give you a list of the names. This particular manufacturing Section includes the majority of the chemical manufacturers who supply brewers with material. It does not absolutely include the whole, but for the purpose of preparing evidence for this Commission, I thought it best to secure samples from the whole of the manufacturers who supply brewers with chemicals.

7202. What are the hardening materials?—Hardening materials are used by brewers for the purpose of raising the mineral matter in their waters to certain standards. The amounts of hardening material added necessarily vary according to the character of the beer which is required, but the maximum amounts generally added are as follows:—

Sulphate of lime - - - -	50	grains	per gallon.
Sulphate of magnesia - - -	10	,,	,, ,,
Chloride of calcium - - -	20	,,	,, ,,
Chloride of sodium - - -	50	,,	,, ,,
Potassium sulphate or chloride -	15	,,	,, ,,
Kainit - - - - - -	50	,,	,, ,,

7203. What is kainit?—Kainit is a natural deposit supposed to have been derived from evaporation of an inland sea. It is obtained from mines in Stattfurt, in Germany. It is mined out of the ground. The coarser varieties of kainit are, I believed, used as a manure. The finer varieties are used for hardening purposes. In some cases they are purified first of all. In other cases they are used without any treatment. Kainit consists essentially of a mixture of potassium sulphate, magnesium sulphate, and sodium chloride.

7204. Are the quantities of the different substances given in this table the quantities of the substances habitually added?—Not the whole of them.

7205. One or the other?—One or the other.

7206. Something of all?—No, not exactly. It entirely depends upon the character of the beer. In some cases chloride of sodium alone would be used. In other cases kainit alone would be used. In other cases a mixture of sulphate of lime and sulphate of magnesia would be used, but in any case the total amount of hardening materials added would seldom exceed 50 grains per gallon.

7207. Is something of hardening material essential?—For certain classes of beer with certain waters.

7208. Is that to please the taste of the consumers?—Yes.

7209. Not to make the beer keep?—It does render the stability of the beer higher, undoubtedly. In Burton, the district from whence the most celebrated pale ales of this country come, the water naturally contains a large quantity of sulphate of lime, and a moderate quantity of magnesia salts. If we wish to brew a pale ale of Burton character in a district other than Burton we add to our water supply the salts which are deficient in that supply; that is to say, we add sulphate of lime and sulphate of magnesia.

7210. And does that make a perceptible difference in the flavour of the beer?—It makes a very great difference in the flavour of the beer. In fact, we cannot produce a high-class bitter beer without the presence of sulphate of lime.

7211. We shall be very much obliged if you will hand in a list of the persons or firms from whom you received samples, and whose works you visited?—Yes, I will do so.* May I explain that the firms whose works I have visited do not by any means exhaust the firms from whom I have received samples. A number of samples have been received direct from my brewery clients; in fact immediately the possibility of the access of arsenic to beer was realised, practically the whole of my clients in the United Kingdom sent to me the whole of their materials, necessarily including their hardening materials and preservatives; so that I have, in that indirect method, analysed practically the whole of the preservatives, hardening materials, yeast, foods, and other materials which have been produced by English manufacturers.

Calcium sulphate.

7212. Sulphate of lime is added in the form of gypsum?—As a rule in the form of gypsum. In a few cases, in place of gypsum, an article called precipitated sulphate of lime is employed. It is employed in place of gypsum because gypsum is rather slowly soluble. When precipitated sulphate of lime is employed it dissolves almost immediately, hence it is sometimes used. Precipitated sulphate of lime is made by suspending chalk, or whiting, which is a purified form of chalk, in water, and adding to it sulphuric acid. The sulphuric acid decomposes the chalk and produces sulphate of lime, which deposits from the liquid. That sulphate of lime is washed, and is then supplied to the brewer, usually in the form of a paste, in which form it is very easily soluble, and is in many ways preferable to ordinary gypsum.

7213. Is it dissolved in the beer?—It is dissolved in the water with which the beer is brewed, and is carried forward into the beer.

7214. Then it is sparingly soluble?—Gypsum itself dissolves rather slowly, being soluble to the extent of a little over 100 grains per gallon.

7215. (*Mr. Cosmo Bonsor.*) When gypsum is put into water the water takes up exactly the amount of gypsum that it can contain?—Undoubtedly, no more.

7216. Gypsum is a Derby spar, which practically makes the same water as the Trent, the waters used in Burton beers?—Yes.

7217. The spring rises in gypsum?—Yes. The gypsum which is added is mined out of the same districts from which the Burton waters are obtained, and instead of drawing our water from Burton we bring the gypsum to the water.

7218. (*Chairman.*) Is there a saturated solution of gypsum? Do you put in as much gypsum as the water will dissolve?—Not quite.

7219. It is not saturated?—It is not saturated. There are objections to complete saturation. We find that if we saturate our water with sulphate of lime the beers do not clarify as quickly as they otherwise would, or as quickly as we desire for the present class of trade.

Salt.

7220. Do you also use common salt?—Yes, it is used usually in the brewing of mild beers, not in bitter beers. The ordinary bar salt of commerce is that form of salt which is usually employed, just the same salt as we use on our tables.

7221. Other sulphates or chlorides are also used?—They are not frequently used; they are sometimes used.

7222. Is that for obtaining various flavours in beer?—For hardening.

7223. And also for flavouring?—Certainly. In certain districts certain particular flavours are desired. In certain districts waters containing large quantities of chlorides produce the desired flavour of beer. In other districts waters containing large quantities of sulphates produce the required flavour of beer. The brewer seeks to treat his water so as to produce a beer suitable to the particular district which he is supplying.

7224. Did you discover any arsenic in any of these substances?—I have discovered arsenic in a few of

*Note by Witness.—This is the list referred to:—Boake, Roberts, A., and Co., Ltd.; Burgoyne, Burbridge, and Co.; Cafferata and Co.; Clowes, Walker, Limited; Collett, J. M., and Co.; Gillman and Spencer, Limited; Hallams, Limited; Kendall, F., and Son; Malto-Peptone Co.; Prentice Brothers; Vanguard Manufacturing Co.; Von Heyden's Chemical Co.

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the materials, but the amount has been extremely small. The largest amount of arsenic which I have found in any material has been in kainit. In that material I have found, approximately, ·02 milligramme in 50 grammes of the material, that is to say, ·0028 grain in a pound of kainit.

Kainit may be arsenical, but should not introduce material quantity of arsenic into beer.

7225. That is grains of arsenious oxide, not so much arsenium?—Not the metal, but the oxide. Assuming that 50 grains of this material were present in a gallon of beer—and that is a very large amount, the maximum which would be present—then even if a material of the maximum impurity which I have examined were used, only ·00002 grain of arsenic per gallon could be introduced into the beer. The amount introduced is so small that it is practically negligible.

7226. The other materials mentioned under this heading contain no arsenic, or less than the above-named amount?—Yes, I have found a small amount of arsenic in some samples of commercial Epsom salts.

Epsom salts.

The amount of Epsom salts which a brewer uses is very small. I have never found more than ·01 milligramme of arsenic in Epsom salts, and, calculated out, based on the amount which an ordinary brewer uses, it comes to the fifth place of decimals; and when we remember that Epsom salts are used in very large quantities, without particular danger to ourselves, medicinally, one cannot think that the use of three or four grains per gallon of Epsom salts can be of much matter when one is in the habit of taking ½ ounce of Epsom salts.

7227. (*Mr. Cosmo Bonsor.*) Do you recommend Epsom salts to be used in beer?—I do not, personally.

7228. (*Chairman.*) Is it according to the taste of the consumers in certain districts that Epsom salts is added to the beer?—It is derived from this, that a certain small amount of magnesium salts is undoubtedly present in some of the Burton waters, and brewers who are endeavouring to produce beers of Burton type perhaps too slavishly copy all the ingredients which are present in the Burton water.

Kainit.

7229. If kainit is a natural earth and occasionally contains arsenic, may not particular masses of kainit be notably arsenical?—That is possible. I can only say I have examined, I believe, about 28 samples of kainit drawn from breweries all over the kingdom, and I have not found any arsenic in 25 out of the 28. But in three I have found arsenic. The largest amount of arsenic which I have found in any of those is, as I have stated, ·02 milligramme in 50 grammes, equal to ·0028 grain per lb., an amount which, I think, is quite negligible.

7230. Is kainit used by a great many brewers?—A considerable number of brewers are using kainit.

7231. Do the brewers get it chiefly direct from Germany, or do they buy it from sellers of chemical materials in England?—Most usually from sellers of chemical materials.

Preservatives used in beer.

7232. What do you say as to antiseptics?—The greater proportion of preservatives used in beer consist of preparations of sulphites, the active agent being, of course, the sulphurous acid (sulphur dioxide) contained in the sulphite. In addition to sulphites, small quantities of salicylic acid are sometimes employed. The quantities in which preservatives are added are quite small, and may, I think, be fairly taken to be as follows: calcium, sodium, or potassium sulphite are used at the rate, usually, of one ounce per barrel of beer. This is equivalent to about 12 grains per gallon. In a few and quite exceptional cases, as much as 1½ ounces per barrel may be used. Of liquid sulphites bisulphite of lime is that most generally used, and is the oldest preservative. It was used before any of the solid sulphites were introduced. The amount of that employed varies very considerably indeed, but generally lies between 6 and 10 fluid ounces per barrel; this is equivalent to about the same actual addition as of solid sulphites. Other special forms of liquid sulphites are supplied to brewers, and of those from 2 to 4 ounces per barrel are added, which are really equivalent to the same amount that I have above named of solid sulphites. Salicylic acid is used to the extent of ¼ or ½, or, in exceptional cases, ¾ of an ounce per barrel, usually half an ounce per barrel, that is, to the extent of 6 grains per gallon. So that it is quite clear, in view of the very small quantities of these materials which are added to beer as preservatives, the very grossest contamination must have taken place to introduce any appreciable amount of arsenic into beer. All these preservatives, so far as I have been able to ascertain, have been made with every reasonable care, and from commercially pure chemicals.

Sulphites.

Salicylic acid.

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7233. I believe you have some information to give us with regard to sulphuric acid in this connection?—Sulphites, the basis of practically the whole of the preservatives supplied to brewers, are produced, of course, by the aid of sulphurous acid, and sulphurous acid is made by one of three methods. First, by the burning of sulphur; second, by heating sulphuric acid with sulphur; and third, by heating coke or charcoal with sulphuric acid. All of the makers of sulphites in England use one of these three methods. In every case of the factories which I have visited, the resulting gases are passed through a washer or scrubber before they are led into the saturation vessel, the vessel in which the sulphite is prepared. I found from direct experiments, a number of which I have made in my laboratory, and on a larger scale in the works, that if arsenic were present in the original acid it is entirely separated when the gases pass through the washer. In fact, the arsenic, if present, is held back in the washing vessel. Every manufacturer, so far as I have been able to ascertain, uses a washer for his gases, and therefore every manufacturer practically secures himself against any arsenic being carried forward into his products. The arsenic which is present in any preservatives, if it is present, is therefore not derived from the sulphurous acid. As a matter of fact, the sulphuric acid which is used in making sulphurous acid is, so far as I can ascertain, and has been, of very good quality indeed. In most cases it has been pure to the fourth place of decimals. I found on examining the books of some manufacturers whose works I have visited, that they have consistently, not lately, but for two or three years past, made examinations of the acid which they have employed, that they have tested for arsenic in the acid, and that they have only used acid which has been reasonably—I will not say absolutely—free from arsenic. The largest amount of arsenic which I have found in any of the sulphites has been ·02 milligramme per 50 grammes, that is equivalent to ·0028 grain per lb. As only about 12 grains of such a preparation is used in a gallon of beer, the actual amount of arsenic introduced would not exceed, in the worst sample which I have examined, ·000004 grain per gallon; in fact, $\frac{1}{250000}$ grain, which is, of course, quite negligible.

Manufacture of sulphurous acid and its freedom from arsenic.

7234. That we may consider as quite negligible?—I think so.

7235. In the case of a beer likely to go sour, might not a much larger quantity of bisulphite or other preservative be added?—It is unlikely. The amounts which I have given you are the maximum. A very large number of brewers do not use as large an amount as I have stated, that is to say, 1oz. per barrel of solid, and 6 to 10oz. of liquid sulphite. It is most unlikely that in any considerable number of cases larger quantities of sulphite than that given would be used. As a matter of fact, if larger quantities were used they would communicate a flavour to the beer, and would render it objectionable. The public taste would not permit larger quantities to be employed.

7236. (*Sir William Church.*) Is boracic acid ever used as a preservative?—I have made enquiries as to that from practically every manufacturer in England, and they all deny that boracic acid has ever been sold by them as a preservative for beer.

Boracic acid not added to beer.

7237. (*Mr. Cosmo Bonsor.*) Salicylic acid is very little used?—Very little.

Salicylic acid seldom.

7238. It is used more for cleansing vessels and casks than for beer?—It may be used for that purpose. The amount of salicylic acid used is very small. The main preservative relied upon by brewers is some form of sulphite.

7239. I take it that in mentioning salicylic acid you mention it because it has been supplied to brewers, but it does not necessarily mean that it has gone into the beer?—No, but it is sometimes added direct to beer.

7240. It is more used for cleansing purposes, for getting rid of bad yeast that has impregnated wood in any form than for any other purpose?—Yes, it is a most powerful disinfectant, and for that purpose is most useful in destroying infection which may have occurred in wooden vessels. It is supplied to brewers, though it is not the main preservative upon which brewers rely.

7241. The principal preservative is bisulphite of lime?—Yes.

Mr. Briant. 4 May 1901.

7242. (*Sir William Church.*) With regard to salicylic acid being used for disinfecting and cleansing purposes, what has led brewers to use it for that purpose? It is not so powerful a germicide as many other things which are known?—No, not so powerful, for instance, as mercury, but we should be afraid to use a mercury salt in the interior of a fermenting vessel which was subsequently to be filled with beer.

7243. That is the very reason I asked you the question. It is used as being a germicide, and as one that is not poisonous?—Certainly.

7244. Except in very large doses?—Yes, that is the point. We wish to disinfect our vessels, which are subsequently to be filled with beer, and although we may wash the preservatives off we could not ensure that every trace of preservative was removed; therefore, though we all admit that mercury is one of the most powerful germicides, its use would be inadmissible and inappropriate for cleansing vessels which are to be subsequently filled with beer.

7245. (*Chairman.*) Is carbolic acid used in any cleansing?—It is not used in any vessels which are to be filled with beer or wort. Carbolic acid may be used on the floors but not added to the beer. The smallest quantity would absolutely ruin the flavour of the beer.

7246. Besides preservatives, there are what are called finings. Have you anything to say about these?—Finings are made from isinglass, the swimming bladder of the sturgeon, and the commoner sorts are made from soles' skins. Some very few samples are made from gelatine. The finings are, as we technically term it, "cut," that is, semi-dissolved by treatment by means of an acid. The acid employed for cutting or dissolving finings in very many cases is sulphurous acid. In some cases tartaric acid is added, as well as sulphurous acid. Sulphurous acid, as I have previously mentioned, is practically arsenic free, and the use of sulphurous acid is therefore not open to any objection. Tartaric acid is used in the preparation of some finings, and tartaric acid undoubtedly does, in some commercial samples, contain traces of arsenic. There is no doubt that it is an extremely difficult thing to get commercial tartaric acid which is absolutely arsenic free by the very rigid test to which we subject materials at the present time. For that reason personally I think it would be wise to reject the use of tartaric acid entirely from the preparation of finings. This is, however, only my own individual opinion. It is quite easy to make finings without their employment, in fact, in my opinion better finings can be made without the use of tartaric acid than with. Assuming that tartaric acid has been used, and assuming that it has been used in the proportion of 1lb. of tartaric acid to every 7lbs. of isinglass, together with 1 gallon of sulphurous acid of 5 per cent. strength, these materials would be sufficient to make a hogshead of finings. Before the hogshead of finings was used, it would be diluted with either water or beer, with an equal bulk, making two hogsheads of finings, and then of that diluted material one pint to one quart would be added to each barrel of the beer. Taking the maximum amount of one quart and the quantity of tartaric acid used as that which I have named, the amount of tartaric acid introduced would not be more than 15 grains per gallon of finings, whilst the amount of sulphurous acid would be approximately half that. I have examined a considerable number of samples of finings for arsenic, and I have found a minute trace of arsenic in two of them. The worst sample that I examined contained arsenic to the amount of ·016 milligrammes per 100 c.c., equivalent, that is, to ·011 grains per gallon. Assuming these finings, which are the very worst that I have come across, to have been used in the maximum amount mentioned, the amount of arsenic which could be introduced into a gallon of beer would be ·00007 grains per gallon. It is quite clear that whilst a very minute amount of arsenic, quite a negligible amount, might be introduced by the use of tartaric acid, the amount which would be so introduced would be nothing compared with the amount which must be commonly taken in the ordinary baking powders of commerce, most of which are prepared with tartaric acid. The amount of tartaric acid present in those must be enormously greater than can be present in beer.

7247. What is the largest amount of arsenic that you have found in tartaric acid?—I have not examined a very large number of tartaric acids. I have examined the finished products in most cases. But I have a few samples of tartaric acid which I have examined. I have one sample of tartaric acid which contained approximately one-fiftieth of a grain of arsenic per lb. of tartaric acid.

7248. Is that the greatest amount?—I have one further sample which contained one-thirtieth of a grain of arsenic per lb. Those are the largest amounts. The amount of tartaric acid used by a brewer in the preparation of his finings is, of course, very small indeed.

7249. The arsenic so introduced would be negligible in beer?—Absolutely negligible. At least I gather that when you come to 1/10,000th of a grain per gallon it is negligible.

negligible as regards beer.

7250. Why should you use tartaric acid? Is it not more expensive than sulphurous acid?—It is not a question of expense, it is a question of convenience, and of quickness in cutting. Tartaric acid is found to cut finings to make them ready for use more rapidly than sulphurous acid, and for that reason perhaps has been used. The most practical brewers are of opinion that very rapidly prepared finings are not always the best finings, and that a slower method of preparation will often give a really more efficient article, and a great number of brewers now from choice prefer the sulphurous acid-made finings.

7251. How is the tartaric acid applied?—It is dissolved in water, and applied to the isinglass?—The isinglass is first of all washed, and soaked in cold water until it swells up. We then add the tartaric acid, which may be previously dissolved, or, in some cases, has not been previously dissolved, and a certain amount of 5 per cent. solution of sulphurous acid, that is, if we are using tartaric acid and sulphurous acid. The isinglass is allowed to remain in this acid solution, and slowly cuts, as we term it, that is to say, becomes disintegrated. Whether it truly dissolves or not is a question which is much disputed. It forms a sort of jelly-like mass.

7252. But is it not a jelly-like mass when it is moistened with water?—No, it is not the same form at all. It swells up into a solid jelly mass, but on cutting with finings it breaks down into a liquid, through which very minute particles of gelatine or isinglass are suffused in a state of semi-solution. We believe it is not true solution.

7253. If you filtered that through an ordinary filter, or blotting paper, would the isinglass be kept back?—Yes.

7254. As it is, it remains suspended in the water?—Yes. When we add that to the beer, then the yeast and other matters suspended in the beer attach themselves to the finings, and agglomerate into one solid mass, and fall through the beer and fine the beer, rendering it quite clear.

7255. Is the beer poured off, or is the sediment removed from it?—It depends upon the class of trade done. For the London mild beer the finings are worked out of the top of the cask, out of the bung hole. The finings are added to the beer, and the gas in the beer buoys up the finings, and they work out of the bung hole. The consequence is, you get a cask of absolutely brilliant beer. In the provinces generally the finings are allowed to work downwards instead of upwards and remain deposited at the bottom of the cask.

Outside London sediment after fining remains in cask.

7256. How is the beer cleared?—Is it drawn off with a syphon or just left?—In an ordinary cask the tap hole is an inch or so above the bottom of the cask, and in that way the finings and the deposit are not disturbed.

7257. So that the beer is left on the lees, as it were, and drawn off gently from the top from above?—Yes, except in the London trade, when the finings are worked out.

7258. (*Mr. Cosmo Bonsor.*) London finings are never made with tartaric acid?—No.

7259. They are made with sour beer?—Yes.

7260. In the case where the finings work through the top, the isinglass is cut with sour beer?—Almost invariably.

7261. (*Sir William Church.*) That is to say, with acetic acid. Why is acetic acid not used for finings?—Sour beer, of course, consists of a mixture of acetic and lactic acids. Brewers are of opinion that the most effective finings are those made with sour beer.

7262. (*Mr. Cosmo Bonsor.*) It is a quick process?—Yes.

7263. (*Chairman.*) Is not sour beer dangerous?—That is the reason why such finings are not so much used with stock beers as they are with beers which are consumed very quickly.

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7264. The sour beer does not leave a bad flavour?—No, the amount introduced is so small.

7265. (*Mr. Cosmo Bonsor.*) In examining finings under a microscope they are practically all small particles?—Yes, in a very minute state of subdivision.

7266. The fining of beer with isinglass dissolved in acid is quite a different process to what fining wine by eggs is?—Quite a different process.

7267. (*Chairman.*) What do the finings do? Is it the gelatinous matter that causes the material that you wish to take out to stick to itself?—The finings, which are in a state of semi-solution, when they are added to the beer, are thrown out of solution and pass downwards or upwards through the beer, according to the method of fining, carrying with them any matters which are suspended in the beer, leaving the beer brilliant.

Manufacture of caramel.

7268. What about caramel?—Most caramels are made from glucose. In many cases liquid glucose is used for this purpose, sometimes solid. American and sometimes German glucose is employed. Some caramels are made from cane sugar, not from glucose. All the manufacturers of caramel from whom I have made enquiries deny that inferior glucose is in any case used by them. They inform me that it is necessary for their purposes to use a thoroughly high quality glucose, and such glucose they always buy. The amount of caramel added in the case of black beers may, in exceptional cases, be as much as 8 per cent. or 10 per cent., but usually it does not exceed 6 per cent.

Proportion of caramel used in beer.

7269. Eight per cent. to the volume measure?—Of the amount of materials employed.

7270. So that there would be 8 or 10 volumes of caramel to 92 or 90 volumes of beer?—No, to 90 volumes of malt and other sugar. Ten per cent. is the expression of the equivalent in what we term a grist of materials used for producing the beer.

7271. The caramels are to be used in brewing?—Yes.

7272. And put in before the brewing is completed—put in at the commencement of the brewing?—After the wort is drawn off from the malt into the copper. The amount of caramel used in some cases is as high as 8 or 10 per cent.

7273. Eight per cent. of the wort?—Eight per cent. of the materials used for producing the wort. Supposing you have a grist of 50 quarters of malt, 8 per cent. of 50 quarters would be equivalent to 4 quarters of caramel.

7274. Then there is a great mass of water over and above that—the materials are put into water?—The caramel is generally added to the copper, and is not added to the mash tun at all. After the malt is exhausted in the mash tun the amount of caramel which is deemed necessary is added to the copper.

7275. (*Mr. Cosmo Bonsor.*) Take a 50 quarter grist; 40 quarters of malt, 8cwt. of sugar, 8cwt. of caramel would make a 50 quarter brew?—That is so.

7275A. That, I take it, is the material with which the beer is commenced?—That is so.

7276. The malt is put into the mash tun, water is added to the malt; the product that comes from the mash tun is pumped into the copper, where the hops and the caramel and the sugar are added?—That is so.

7277. (*Chairman.*) I do not see the percentage yet. What does the 8 per cent. refer to?—It is 8 per cent. of the excise brewing.

7278. I am afraid I do not understand, and I would like to know what it means?—I will be very pleased to work out an exact example for you.*

7279. How is caramel prepared?—Caramel is prepared from glucose, sometimes from cane sugar, and is prepared by heating, by "caramelising," as we term it.

7280. It is prepared in the purification of sugar, when it is conducted at a certain temperature?—Caramel is not a by-product of the purification of sugar. It is specially prepared.

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7281. But does it not also occur in the preparation of sugar by some of the older processes?—There is no doubt that the exposure of sugar solution to a high temperature, as used to occur before vacuum pans were used, did produce a certain amount of colouring of the sugar.

7282. That was not done by design, but now you make caramel by design?—Yes.

Arsenic found in German caramel.

7283. How is the caramel used?—The caramel used by brewers is either a thick viscid liquid, which will only just pour, which has a specific gravity of about 1300, or in the solid form, more usually in the liquid form. The solid form is about one-fifth stronger than the liquid. The whole of the caramels that I have been able to obtain have been tested for arsenic, and I have found no arsenic in any caramel of English manufacture. I have found arsenic in two samples of German manufacture, in no case exceeding one-hundredth of a grain per lb.

7284. My questions with regard to the percentage were absolutely necessary in order to understand how much arsenic one-hundredth of a grain per pound of caramel could introduce?—Just so. Assuming that in the production of a black beer caramel was used to the maximum extent, then not more than 4oz. of caramel could be used, and taking the very worst example of caramel which I have ever examined, the caramel could not introduce more than 1-400th grain of arsenic per gallon to the beer. But such a caramel as I have mentioned (the German-made caramel containing arsenic) would not be used by a brewer. Every brewer would reject it.

7285. Reject it now. But had caramels ever been tested before for arsenic?—I think not.

7286. Is there any knowledge of sulphuric acid having been used in the manufacture of caramel?—Sulphuric acids are not used in the manufacture of caramel. Caramel is made by heating glucose, or cane sugar, either by itself, or sometimes by the addition of ammonia salts, such as carbonate of ammonia or carbonate of potash—that is by the addition of alkali, but not of an acid, to sugar or to glucose.

7287. Going beyond beer, to which this Commission is not limited, it becomes a very important question to know whether caramel is liable to be contaminated with arsenic. The caramels that you have examined, which have been made for beer, are the same as the caramels that are used for general food?—I believe that many of the caramels which are supplied to brewers are also supplied to the public.

7288. They are largely used?—They are very largely used, of course, for colouring purposes.

Yeast food

7289. Is there any risk of what are called yeast foods becoming contaminated with arsenic?—There are two sorts of yeast foods used, yeast foods which consist practically of phosphates and yeast foods which consist of nitrogenous matters. The yeast foods which consist of phosphates do, in one or two cases, contain minute traces of arsenic. The amount is very small, but they do, undoubtedly, contain it. I believe that is derived from the phosphates themselves, for so far as I have been able to ascertain it is extremely difficult at the present time to get any phosphate of commerce which is absolutely free from traces of arsenic. Almost the whole of the phosphates of commerce I believe contain minute traces of arsenic. Therefore, yeast foods which are made with phosphates are liable to contain a very small trace of arsenic. But when one considers the amount of yeast food which is used it becomes apparent that the danger of poisoning is nil, because the amount of phosphatic yeast food which is employed is not more than 1lb. to thirty barrels of wort or beer. The yeast food is added during the fermentation. The yeast food does not consist entirely of phosphates, but of a mixture of phosphates and such substances as malt, pea or bean flour. In two samples of phosphatic food I have found traces of arsenic. The largest amount found has been ·02 milligrammes, which is a very small amount; and in view of the very small quantity of such food which is added to the beer I think the amount is quite negligible.

Phosphates may contain arsenic, but this proportion in beer very small.

7290. Are the words "yeast food" technical words in breweries?—The liquid or wort extracted from the malt in which yeast grows is sometimes deficient in certain of the constituents which the yeast requires for its nutriment. Being deficient we add to that wort a food.

* Example.—A 20 quarter brew of black beer might consist of 15 quarters pale malt, 2 quarters of black malt, 1 quarter of amber or crystal malt, 2 quarters of sugar; total, 20 quarters. Now, 2 cwt. of caramel is approximately equal in colouring power to 1 quarter of black malt. If, therefore, one-half of the black malt were replaced by caramel, we should use 2 cwt. (= 1 quarter of black malt), and should speak of the proportion of caramel as 5 per cent. in the total grist.

7291. A food for the yeast to draw upon?—Yes. Just in the same way that we might add to the ground certain manures for supplying the plants with their food, so we sometimes add food for the yeast plant. Those foods are either phosphatic or nitrogenous. In the case of phosphate yeast foods, minute traces of arsenic have been found, but so minute as to be practically negligible, remembering that only about 1lb. of phosphatic yeast food is added to thirty barrels, or 900 gallons, of beer.

7292. Since the epidemic, brewers have demanded the phosphatic yeast foods to be free from arsenic?—Absolutely arsenic free. There are also nitrogenous yeast foods. These are made in some cases from malt rootlets, in others from some nitrogenous material, the source of which I do not know. The nitrogenous foods made from malt rootlets are made entirely from malt rootlets which have been dried with anthracite coal, and have always been so made because it was found that the flavour was injured if rootlets were used from malt which have been dried with gas coke. The malt culms which have been used have been always practically free from arsenic, and inasmuch as the amount of yeast food added is only about 1lb. to twenty or thirty barrels, sometimes considerably less, it is quite clear that the amount of arsenic introduced is perfectly negligible.

7293. (*Dr. Whitelegge.*) Is not a considerable quantity of arsenic found sometimes in sodium phosphate?—That is so.

7294. I have an example before me which was found to contain ·072 per cent., or five grains of arsenious oxide per lb. That is a much larger quantity than you have met with?—Much larger.

7295. So that on that basis a material increment of arsenic might occur in the beer?—Undoubtedly. It is very difficult to get phosphates which are absolutely free from arsenic at present.

7296. (*Chairman.*) Is that because of sulphuric acid having been used in the preparation of the phosphates?—Yes, I believe so.

7297. In general, are the firms which you have visited taking precautions as regards arsenic?—They are taking every precaution which they are able to take. In every case they have chemists who test the products which they make. The whole of the materials as they come into the works are carefully tested before they are accepted, and every precaution which can be taken is now being taken.

7298. Are they asked to guarantee their products as arsenic free?—Almost invariably.

7299. And do they do so?—They do so.

Mr. L. Brunt. 1 May 1901.

Manufacturers of brewers' chemicals now taking precautions to exclude arsenic, and guarantee their chemicals to be arsenic-free.

FIFTEENTH DAY.

WESTMINSTER PALACE HOTEL.

Friday, 10*th May*, 1901.

PRESENT:

Sir WILLIAM CHURCH (in the Chair).

Prof. THORPE. | Dr. WHITELEGGE.

Mr. COSMO BONSOR.

Dr. BUCHANAN, *Secretary*.

Mr. EDWARD WILLIAMSON, called; and Examined.

7300. (*Chairman.*) You are the Secretary of Bostock's and Co., Ltd., I believe?—I was the Secretary of the late Company.

7301. They are now in liquidation?—That is so.

7302. And you are desirous, I think, of putting in a statement to the Commission?—Yes. In view of this action which we have entered against Messrs. Nicholson; perhaps it would be better if I were allowed to hand in a written statement. If questions were asked they might lead in some way to a prejudice of the case pending.

7303. This, I believe, is your written statement?—Yes; and with your permission I will hand it in.

7304. Since it was printed, I think, your statement has received some manuscript corrections?—Yes; that is, slight alterations.

7305. And you are therefore content that this as it now stands should go in to the Commission?—Yes.

7306. The Commission do not propose to in any way cross-examine you upon your statement, but there are a few questions bearing upon it which we wish to ask you. We understand that there is a considerable amount of glucose and invert sugar which is contaminated with arsenic still in possession of the liquidators?—Yes; that is so.

7307. Besides that which was left on your hands, I understand that some is what has been returned to you from the brewers whom you had supplied?—Yes; that is so.

7308. Could you give the Commission any idea as to how much there is?—At present I think we have about 700 tons.

7309. (*Prof. Thorpe.*) Do you refer to both glucose and invert?—Yes.

7310. (*Chairman.*) Has any been disposed of since it was found to be contaminated?—About 100 tons altogether.

7311. In what way?—We have disposed of it for textile purposes to calico printers who use it, to tanners and curriers, and we have sold it to various drysalters as middlemen. We have, however, stated on the invoice that it was contaminated with arsenic and unfit for food and drink purposes. We thought at the time we might sell it on those lines.

7312. (*Professor Thorpe.*) Have you sold both invert and glucose?—No, glucose only.

7313. (*Chairman.*) With no other safeguard except your statement that it was contaminated with arsenic?—That is the only safeguard.

7314. The sale was made on behalf of the liquidators, I suppose?—Yes, principally, the liquidators were not appointed until the 1st of April, and that was on account of the Official Receiver.

7315. Do you know whether the liquidators propose to take steps to sell it in the same way or in any other way?—That is their intention.

7316. Is there no way by which the public could be more safeguarded from accident? We know some of your sugar was used by children to make toffy, and with bad results?—We were not aware of that.

7317. They took it from a brewer, and they might in the same way take it from a leather-dresser's store?—If you think it necessary, or can suggest any other method

Mr. E. Williamson. 10 May 1901.

Sale of arsenical glucose as such.

Mr. E. Williamson.

10 May 1901.

of safeguarding the public, I have no doubt it will be done.

7318. It is not for the Commission to suggest; I ask you whether you would make any suggestion on the point?—I really do not know what other safeguard we could adopt; that is, if it is intended to be sold at all. Of course, it could be destroyed.

7319. 700 tons of poisonous substance I suggest to you is a very dangerous thing?—Yes, if there is any chance of it getting into a food product it would be dangerous.

7320. Is there any way in which it could be stained so that nobody should think of using it for food? Is there any means by which it could be made disagreeable to the taste?—If you did that you might render it useless for textile purposes; that is the only thing which occurs to me.

7321. (*Prof. Thorpe.*) It is quite conceivable to make it repulsive by the addition of small quantities of material which would not affect its use for commercial purposes as you suggest, but would entirely prohibit it from being used as food?—If that can be done, I have no doubt it will be done.

7322. (*Chairman.*) I do not think it is for the Commission to suggest that, but I think it is a part of the Commissioners' duty to suggest that this substance should not be parted with by Messrs. Bostock, or by the liquidators, except with such precautions as are necessary to guard against accident from its use?—Yes, that is a matter which I will put before the liquidators for their consideration before they dispose of any more.

No action by M.O.H. regarding Bostock's arsenical sugars.

7323. (*Dr. Whitelegge.*) Has the Medical Officer of Health for Garston been consulted about this stock?—He has not.

7324. He has taken no action in the matter?—No.

7325. (*Chairman.*) I put this before you. I think before this substance is parted with the Commission ought to be informed as to what steps it is proposed to take?—Very good, sir; I will see that you are informed.

Mr. E. Williamson.

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7326. I think you received a letter from the Commission, dated 19th Feb., in which the Commission stated that they would be obliged if you would inform them at an early date of any proposals which may be made for disposing of the sugars in question?—Yes, that is so.

7327. And you acknowledged the receipt of that letter, writing, for Messrs. Bostock, "We beg to acknowledge the receipt of your favour of yesterday's date, re our stock of contaminated sugars, which we will bear in mind"?—Yes.

Additional precautions promised.

7328. Notwithstanding this, we have at no time received any information from you that any was disposed of?—That appears to have been overlooked. It has been in many people's hands since that date. We went into voluntary liquidation, then into the Official Receiver's hands, and now the firm has gone into compulsory liquidation, and in that way the communication appears to have been overlooked.

7329. It is a very important thing to be overlooked; our letter was addressed to the liquidators?—Yes.

7330. Whether they are compulsory liquidators or not, it was addressed to the liquidators?—I believe at that time it was in the hands of the Official Receiver, and that letter was handed to him.

7331. Perhaps you will take all steps necessary to ensure that there are no other omissions?—I will. I will undertake to.

7332. And you will keep the Commission informed of the destination of any of your invert sugars or glucoses if disposed of, and what precautions have been taken, or what precautions you intend to take, and what is the destination of any which is disposed of?—I will see that this is done.

Mr. E. G. Francis, called; and Examined.

Mr. E. G. Francis.

7333. (*Chairman.*) I believe you are manager of the Manbré Saccharine Company?—Yes, and also director.

7334. You have occupied the position of manager for 23 years, I think?—That is so.

7335. During the first two years of that period the works were in Booth Street, Spitalfields, and the rest of the time at Fulham Palace Road, Hammersmith?—Yes.

7336. During the whole of that time the sulphuric acid used in the works has been supplied by Messrs. James Gibbs and Company, Limited, of Victoria Docks, with the exception of a few weeks in 1892?—That is so.

7337. Has there been any difference in the acid during those years?—Until the end of 1891 the acid was made from brimstone, but after that it was made for a period from pyrites, followed by an interval of three years, during which it was made from brimstone, and since then from pyrites.

Pyrites acid commercially represented as being made from brimstone.

7338. What was the cause of your changing the source of your acid?—It was clearly understood that the acid which we used should be made from brimstone, and towards the end of 1891 the manager of Gibbs and Company called upon me, and said he was very sorry, but he could not supply me any longer with brimstone-made acid as the demand for that acid has declined so much that it did not pay to make it. He proposed to substitute an acid made from pyrites, which he guaranteed should be equally as pure as the brimstone-made acid. In fact, he said that he might have sent me that acid without my knowing anything about it, it was so pure. But he, knowing that I had this predilection for brimstone-made acid, thought it only fair to tell me he was about to discontinue its manufacture.

7339. You did not accede to that, I believe?—I was very nervous about using that acid, because I quite realised the tainted source from which it was made, and I preferred, if possible, to continue to use the brimstone-made acid. In the end I was obliged to leave Gibbs and Company because the manager said he could not supply me with any other kind of acid than that made from pyrites. Accordingly, I ultimately got a supply from Messrs. Wallace and Company, who undertook to give me the acid I wanted.

7340. You subsequently found out that Messrs. Wallace and Company were not supplying brimstone acid?—Yes, in a few weeks' time the same manager of Gibbs and Company called upon me, and said that he presumed the acid we had been using was satisfactory since we left them, or he would probably have heard from me. He said he thought it only fair to state that the acid which Wallace and Company were supplying to us was bought from him, the manager of Gibbs and Company, and sold to us as brimstone acid. On learning this I lost confidence in Wallace and Co., and accordingly went back to Gibbs. I had more confidence in Gibbs and Company than Wallace, especially after that incident.

Mr. E. G. Francis.

7341. Did you ever find that the acid that you got through Messrs. Wallace contained any arsenic?—No, it was quite as pure as the acid we used before.

Prefers brimstone acid, but satisfied that pyrites acid is satisfactory.

7342. Had you any guarantee, when you went back to Messrs. Gibbs? Did you ask them to give you a guarantee as to the purity of their acid?—No, I was satisfied. I have shown that I had every reason to repose the utmost confidence in Messrs. Gibbs. The manager came to me after the change, and told me frankly he could not supply brimstone-made acid, and accordingly I felt that I could have the same confidence in him as I had before.

7343. Subsequently you had some further trouble?—I was always nervous about the pyrites acid, and I pressed him to make it from brimstone if he could, and he wrote me a letter saying he was about to resume deliveries of brimstone-made acid, and for about three years from that date he supplied me with that, but there was no obligation on his part to do so. He knew of my predilection.

7344. (*Chairman.*) Towards the end of 1898 I believe Messrs. Gibbs and Co. intimated to you that they were going to discontinue the manufacture themselves of sulphuric acid?—Yes, they said they were about to give up making acid, but they undertook to supply me with an acid of equal quality to their own make, made by the well-known firm of Spence, Chapman, and Messell, acid just as pure as that which had been supplied by Messrs. Gibbs and Co. But I did not know the people, and I thought it would be better to have a guarantee.

7345. In that matter Gibbs and Co. were only acting as agents for Spencer, Chapman and Messell?—Yes; I did not know Chapman's then, but I have known them since, and I know them to be a firm of the highest repute; but I thought it was as well to have a written guarantee that the acid should be free from arsenic.

E. G. ncis. ay 1901.

7346. With Messrs. Spencer, Chapman and Messell you have made yearly contracts?—I have made them with Gibbs and Co., but I knew soon after we commenced to use the other acid that it was Spencer, Chapman and Messell's, and since then for the last three years I have had this guarantee that it should be free from arsenic.

7347. And the guarantee is worded as follows, I think. "Guaranteed free from arsenic, iron, and nitrogenous compounds?"—Yes, I have the contract here. I have also an earlier one than that. I hand you the first contract, dated 7th December, 1898. (*Handed in.*)

COPY.

London, E.C., 7th December, 1898.

Contract No. 4,874.

Messrs. The Manbré Saccharine Co., Ltd.,
Hammersmith, W.

We have this day sold to you the undermentioned goods:—

Quantity.—Your total requirements from 1st December, 1898, until 31st December, 1899.

Goods.—Sulphuric acid, 70 per cent., guaranteed free from arsenic, iron and nitrogenous compounds.

Price.—Forty-two shillings and sixpence per ton.

Delivery.—As required, in vanloads delivered to your works in carboys.

Payment.—Monthly account, less 2½ per cent. discount.

Conditions.—Customary. Carboys to be returned from time to time or paid for as may be arranged.

Yours faithfully,

JAMES GIBBS AND CO.,
(Sd.) L. E. Strong,
Secretary.

of tee by ric aker.

7348. The guarantee in the contract for the current year is worded, "Guaranteed practically free from arsenic"?—Yes.

7349. The one which you hand in says, "We have this day sold you the undermentioned goods, sulphuric acid, 70 per cent., guaranteed free from arsenic, iron, and nitrogenous compounds"?—Yes, that is so.

7350. It says, "Delivered in vanloads to your works in carboys"?—Yes, and the other contracts have been worded in the same way, except the present contract, which is worded slightly differently.

7351. Did you take any steps to check the deliveries yourself?—Yes, we tested them occasionally.

7352. And did you ever find that the substance contained arsenic?—No.

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7353. Upon learning of the accidents that had happened in Manchester, did you take any particular steps?—We at once examined first of all every particle of sugar that we had in our works also all the sugar which we had in the depôts, because we thought it better to make doubly sure that there was no possibility of any of our sugar being contaminated. We examined every pound of sugar that we had in the place, not only in the factory but in the various depôts, and the same with regard to our customers' stocks, for they had several hundreds of tons at that time. It was all tested.

7354. And you found none of it contaminated?—None at all.

carboy now for

7355. Therefore, in your opinion, with proper care, there is no risk of the invert sugar being contaminated?—Absolutely none whatever. In the first place, since this outbreak of poisoning we examine every carboy of acid, and although we were particular before,—of course, everybody else is now—we are more particular than ever. With a precaution of that kind, which, after all, is only common sense and easily done, there can be no possibility whatever of contamination. I should like to mention, while I think of it, if I may be allowed to do so, that I understand Mr. Garton, in his evidence, before you, has stated that as large a percentage of acid as used as 8 per cent. in the conversion of glucose. I think he must have been mis-reported, or that he must have made some error, because it is a most important point. We can effect our conversion with less than 2 per cent.

7356. That is of invert sugar?—No, of glucose.

7357. What pressure do you use?—We use 60 to 65 pounds.

7358. The amount of pressure makes a considerable difference?—Yes, but our process was at one time a patent, it is a high conversion process, and by that means we are enabled to use the minimum amount of acid, and I can state that we never exceed 2 per cent.

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7359. (*Professor Thorpe.*) The amount of acid depends on the purity of the starch that you start with, does it not?—Of course, the purer the starch, the less acid. If we could use quite a pure starch we could do it with less than that quantity; but taking all the materials we use, our percentage comes out very much less than was stated to you by Mr. Garton.

7360. You use pure starch?—We use the purest we can get, but I thought it best to correct the statement of Mr. Garton, because it is rather misleading if people get the idea that an inordinate quantity of acid is used, which may or may not be tainted. Such a statement naturally adds to the degree of scare in the public mind.

7361. When Mr. Garton was giving his evidence I might say he was comprehending the whole of the trade. I believe he told us he himself used a special character of starch material, and as a matter of individual practice it is only very exceptionally that he used so large an amount of acid as he indicated?—I think it only fair to say that we at any rate have never exceeded 2 per cent.

7362. But in the case of making glucose direct from maize, is it not the practice to use a larger amount?—It is not made from maize direct. I draw a distinction between maize and maize starch.

Glucose not made direct from maize.

7363. But I think glucose is made from maize directly, is it not?—I do not think it is made directly from maize. The only people who used it in that way were Johnsons' Saccharum Company; and they commenced by making it direct from the grain, but they had to abandon that because it was more or less of a failure.

7364. Is it a fact that when you make glucose from second grade tapioca, you require more acid?—In our particular case we never use more than two per cent.

7365. Do you exclusively use sago and tapioca?—No, not exclusively; we use sago, tapioca, and maize starch.

7366. (*Mr. Cosmo Bonsor.*) Do you use rice-starch?—No, not rice.

7367. Do you use Sarawak flour?—Yes, we use that too. As far as my experience goes, whatever material you may use I cannot see the necessity for using such inordinate quantities of acid as 8 per cent. I thought it probable that Mr. Garton had fallen into error, or that he had been misreported.

7368. (*Chairman.*) Do you wish the Commission to understand that you in your works use not more than 2 per cent. of acid? Of course we know that you use a considerable amount of steam pressure?—Yes, we use probably a higher pressure than anybody else. Our plant was so arranged, and it was a patent under which we worked years ago. We have maintained that plant ever since. It is a high conversion, and a more rapid process than one at a lower temperature.

7369. What you want us to understand is that, in your opinion, in the manufacture of glucose there is no valid reason why such a high percentage of acid should be used?—I do. I rather want to make a point of that.

Brimstone acid should mean acid from natural sulphur.

7370. (*Professor Thorpe.*) You have made it clear to us what you understand by brimstone acid?—Yes, I mean acid made from pure brimstone, not pyrites.

7371. Would the acid made from recovered sulphur be to your mind brimstone acid?—No, nothing would convey the idea to my mind that it was brimstone-made acid unless it were made from sulphur.

7372. Recovered sulphur?—I should not regard that as brimstone-made acid.

7373. You mean the native product then, I suppose?—Yes, Sicilian sulphur, uncombined with any other material. I should imagine, according to my simple understanding—though people may take different views, perhaps—that brimstone acid would be made from that source alone.

7374. Would you understand by that, acid made from Sicilian brimstone?—Yes, I would. I do not mean to say that acid as pure cannot be made from other material. The acid we use is made from pyrites. I have since the scare, especially knowing the prejudice existing, tried to get a supply of brimstone-made acid, not because I think it is any better, but simply on account of the prejudice, if you like to call it so, which exists against the use of pyrites-made acid. I have tested endless samples of brimstone acid, but I have never found

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acid so pure, on the whole, as the acid which I am using now, made from pyrites.

7375. In the case of brimstone acid no particular pains would be taken to free it from arsenic?—That is so. I do not think a man who gets acid made from brimstone would look at it so closely as acid made from pyrites.

Pyrites acid may be better *qua* arsenic than brimstone acid.

7376. Is it your idea that by virtue of the purification which would have to be gone through in the case of acid made from pyrites, it would be a purer product than the brimstone-made acid?—I am sure of it. Knowing as much as I do about it, and knowing that I am now dealing with a firm of repute, I feel safer in using that acid than any acid made from brimstone, assuming that we did not look into it as closely as we do. On that assumption I can see the possibility of brimstone acid containing minute traces of arsenic.

7377. (*Mr. Cosmo Bonsor.*) Which test do you use?—Marsh's.

7378. Entirely?—Yes.

7379. I understood you to say you were prepared to give a guarantee with your goods?—We do.

7380. A guarantee that they are absolutely free from arsenic?—We do; we state it on each invoice.

7381. Are you prepared to agree that that guarantee should be checked by a Public Department after the goods are delivered?—Yes, I believe it is checked by our customers.

7382. By the brewers or by the Public Authority?—Certainly. I should be only too pleased for it to be checked.

Form of guarantee by sugar maker.

7383. (*Professor Thorpe.*) But is your guarantee signed by anybody, or is it a general guarantee?—We print it now on the invoice. We used to write a letter previously to each customer, giving the guarantee, but we find that customers are satisfied with a guarantee printed on the invoice. It says, "We guarantee the above goods free from arsenic." They are satisfied with that.

7384. At your works you have a chemist, I suppose?—Yes, we have three.

7385. So you do your own testing?—Yes, all the operations are tested.

Records of tests kept since the epidemic.

7386. (*Dr. Whitelegge.*) Do you keep a record of the analyses made?—We do now. We did not before, but now we keep a record of all the tests we make.

7387. You keep a record whether the results are positive or negative?—Yes.

7388. Prior to 1891 you were aware of the danger from arsenic?—I was always aware of the danger of arsenic being in acid, especially that made from pyrites.

7389. It was a matter of common knowledge?—Yes.

7390. Was there any question of arsenic involved in that temporary change from Messrs. Gibbs to the other firm?—I was afraid of it, and preferred brimstone acid.

7391. You told us that during a period of three years, 1894-6 inclusive, a reversion was made to sulphur-made acid?—I had always a prejudice, if you like to call it so, in favour of brimstone-made acid.

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7392. Can you tell us whether that intermediate change was due to any suspicion of arsenic?—No, it was not; there was no question of arsenic.

7393. You make brewing sugars, I suppose?—Yes.

7394. Glucose and invert sugar; nothing else?—Yes, and caramel.

7395. Do you supply to brewers direct?—We do.

Manufacture is almost entirely for brewers

7396. Do you supply to any other persons?—No, we deal solely with brewers, with the exception of a few tons occasionally to a dealer. But our trade is directly with brewers, you may say, almost entirely.

7397. And you have no knowledge of the sugars you make passing into other hands for industrial purposes or for making jams or syrups?—No, it would not do for making jam, because it is solid glucose; liquid glucose is used for that.

7398. You do not know of any other industrial application of it?—Only brewing.

7399. What about textile manufactures?—No, it would be too dear for them.

too dear for textile purposes, &c.

7400. (*Chairman.*) You said you did not know of any other industrial application. We have just heard from another witness that some of Bostock's invert sugars and glucose has been sold for the purpose of calico dressing?—I have never known it used for that, but I have known it used for giving a fictitious weight to leather. Our stuff is too dear for purposes of that kind. It is a commoner kind which is used for that purpose. I have not heard of any other industrial use of it.

7401. (*Mr. Cosmo Bonsor.*) You said just now that you made glucose, invert sugar, and caramel. Have you made any maize flakes?—Oh, yes, we have; we do make that too.

No acid use in flaked maize.

7402. Do you use any acid for the purpose?—No, none at all.

7403. Could you give, in a few words, a description of the process from maize?—Yes, we purify it to free it from germs and husk, then reduce it to grits; these grits are then gelatinised and passed through rollers, and the result is flakes. The flakes are then dried in dryers, after passing through these rollers. There is no acid used in the manufacture at all.

7404. So there is no opportunity of contamination?—There is no possibility whatever of contamination, none whatever.

7405. Would you mind our seeing one of your invoices?—Certainly. You will see that it is an invoice specifying the goods in writing in the ordinary way, and that below the specification, at the foot of the invoice, we print: "We guarantee the above goods free from arsenic."

Mr. Rudolf Frederick Wahl (Managing Director, Nord-Deutsche Kartoffel-Mehl Fabrik, Ltd., of Custrin, Prussia), called; and Examined.

Mr. R. F. Wahl.

7406. (*Chairman.*) I believe you are the Managing Director of the Nord-Deutsche Kartoffel-Mehl Fabrik, Ltd., of Custrin, Prussia?—Yes.

7407. Although the Limited Company only dates from 1901 it is a very old business, I believe?—The Company was formed in 1870, upwards of 30 years ago. Before then my father and my grandfather were manufacturers on the Rhine.

German farina is purified potato Starch.

7408. You make, I believe, three principal products, purified starch or farina, dextrine, and glucose?—Yes.

7409. The first is manufactured for the purpose of making the other two?—Yes, that is so.

7410. What is the farina, dextrine and glucose which you manufacture chiefly used for?—Farina is used partly for food purposes and also in the textile, paper, and other industries. It is very largely used in Manchester, and for similar purposes all over the world.

7411. For giving body to calicoes?—For sizing and for foodstuffs. It is very largely used in making macaroni and for thickening sauces. It is very largely used for vermicelli in Spain and also in Italy for the same purpose.

7412. What is the farina, chiefly prepared from?—From potatoes.

7413. The amount which you manufacture is, I believe, very large?—Yes.

Mr. R. F. Wahl.

7414. Will you give the Commission some idea of the amount of farina which you annually manufacture?—It varies very much according to the crop. When the crop is abundant the sales vary accordingly; but on an average, I think about 20,000 tons of farina alone is our quantity.

7415. You estimate that the whole manufacture of the material amounts to something like 250,000 tons a year?—That is a bold guess; but taking into consideration that Germany, Holland and France are about the only countries in which farina is manufactured in large quantities, we can form an idea that this is about the correct quantity. We cannot say whether it is absolutely correct, as we have no statistics on that point.

7416. Is the term farina exclusively applied to potato starch?—Yes, I should say so. Farina is also called potato flour and potato starch.

7417. (*Professor Thorpe.*) Maize starch is never called farina, is it?—I have never heard it called so.

7418. (*Chairman.*) The preparation and purification

of farina is purely and solely by mechanical means; no chemicals are used at all, I believe?—No, no chemicals are used. We never use chemicals for it.

7419. You say you never do?—No.

7420. I suppose you have never heard the wholesomeness of farina manufactured from potatoes called in question?—Never.

7421. It is quite freed from nitrogenous matters?—Oh yes, I have brought you some samples of farina which are our products. (*The witness handed samples to the Commission.*)

7422. How do you make the dextrine from your farina?—By calcining with the use of acid, with a very small addition of acid.

7423. (*Professor Thorpe.*) What acid?—Nitric acid.

7424. (*Chairman.*) That is not used in any way as a foodstuff?—Never.

7425. It is required for what material?—Also for textile purposes and for mixing with colours for paper-hangers, and for coating labels, for gummed papers, and so on.

7426. It is the basis of most of the gums in use, I believe?—Yes.

7427. The commoner gums, of course?—Yes; the commoner gums.

7428. That is, comparatively speaking, a very small part of your manufacture of dextrine?—It is not so very small; we make about 5,000 or 6,000 tons of that a year; that is, of dextrine. That is also largely used all over the world; it is used in England, and goes to America, Spain, and Italy. Of course, Germany is our principal market.

7429. Your glucose is used, I suppose, almost entirely as a foodstuff?—Not entirely. I was listening to what was said before, and I may say that in Germany it is used occasionally for textile manufactures, and also for paper-making. In this country it is not so much used for the textile industry.

7430. (*Mr. Cosmo Bonsor.*) Do you refer to glucose?—Yes, glucose.

7431. (*Chairman.*) How do you make your glucose?—We make it with brimstone acid, and in the usual way, that is, with pressure. I have been hearing what was said about the percentage of acid used, and I can only say we use considerably less than that which has been stated in this room as the lowest quantity.

7432. Do you mean less than two per cent.?—Yes; considerably less.

7433. Mr. Francis said he used considerably less?—Yes, but we use less than one-half.

7434. Do you use very high pressure?—Not very high.

7435. He told us what pressure he used; do you object to telling us what pressure you use?—I do not mind saying we use two atmospheres; that is 28lbs. to the square inch. Of course, for liquid glucose less acid is used than for solid glucose.

7436. (*Professor Thorpe.*) All your glucose, I suppose, is made from purified potato starch?—Yes.

7437. Short of water, it is 99 per cent. of starch, with very little ash in it, I suppose?—Yes.

7438. It is a product which should be converted with a theoretical minimum quantity of acid?—That is so. You have the starch in front of you.

7439. (*Chairman.*) And the purer the starch the less the percentage of sulphuric acid necessary?—Yes; but it is not only purity, but consistency which is aimed at. If you boil starch which is very thin, and take three parts of water to one part of starch, you require more acid than if you have a very condensed liquid starch to deal with.

7440. Do you know what your glucose is chiefly used for in the matter of foodstuffs?—Yes; in Germany it is largely used for brewing, and also for the improvement of wines.

7441. Do you know what proportion the German brewers use the glucose in?—I could not say.

7442. Nor the wine makers?—No, I do not know anything about that.

7443. I think it is not only used in Germany for wine making, but also in France and Italy?—In France very largely, certainly.

7444. (*Mr. Cosmo Bonsor.*) For champagne?—No, it cannot be used for champagne. I daresay it has been tried, but glucose is not adaptable for champagne making, but for clarets it is used to a large extent.

7445. (*Professor Thorpe.*) You say it is used for the improvement of wine. How does the addition of glucose improve the wine?—It is used for the improvement of inferior vintages. When there is little sun in the summer and the grapes are very sour, sugar is added to decrease the acidity of the grape, and the added sugar helps to get the alcoholic strength.

Use prohibited in Bavarian beer.

7446. (*Chairman.*) Its use is prohibited, I think, in Bavaria, Wurtemburg, and Baden, is it?—Yes, for brewing purposes.

7447. Why?—For political purposes. I suppose the Farmers' League has got a very strong hold, or strong representation in their Parliaments, and thus it has been brought about that it is prohibited.

7448. They have prohibited any substitute for malt in brewing, I believe?—Yes, they have prohibited any substitutes, although it is publicly known that they do use substitutes—they smuggle them in in Bavaria.

7449. Still, we do not recognise the breaking of the law here?—Well, we do not sell any to those countries for purposes for which they are prohibited.

7450. Can you, of your own knowledge, inform us that it is the law in Bavaria, Wurtemburg and Baden that no malt substitute should be used for brewing?—Yes, but that does not refer to wine. Bavaria is not a wine-growing country, but in Wurtemburg they make wine from fruit, such as apples and pears, and for cider it is very largely used.

7451. (*Professor Thorpe.*) There is a certain amount of wine-growing in Baden, I believe?—Yes.

7452. Is glucose used in conjunction with the wine industry in Baden?—Yes, as far as I know.

Quantity of glucose used in German breweries

7453. (*Chairman.*) You inform the Commission that 10,000 tons, or not less than 10,000 tons are used in Germany alone?—Yes.

7454. For beer and wine?—Yes, quite so.

7455. Not less than 6,000 tons employed in German breweries for the years 1898 and 1899?—Yes, and the consumption is increasing.

7456. Is there by law any restriction in Germany to the amount of glucose in beer?—I should not think so.

7457. No restriction at all?—I think not.

7458. Do you know at all what is the average amount added to the malt?—I could not say.

7459. You say in common with rice, which is largely used in Germany, its use is recognised and regulated. I thought you might be able to tell us what the regulation was?—It is simply regulated by the excise duty which is paid on glucose in beer making. The brewers have to pay.

which pay duty on glucose used.

7460. The Government in Germany reckon so much glucose as the equivalent of so much malt, do they?—I do not know how they reckon it. I know there is a duty, amounting, I think, to 8s. per 100 kilos, equal to about 4s. per cwt. on glucose.

7461. (*Dr. Whitelegge.*) Do you refer to glucose used in brewing, or to glucose generally?—I refer to brewing.

7462. There is no duty on glucose as such?—No.

7463. (*Mr. Cosmo Bonsor.*) Could you tell us whether in those countries where glucose is forbidden to be used for brewing, beer brewed from glucose is also prohibited from being imported?—It is not prohibited from importation.

7464. So you could import beer brewed from it, though you are not allowed to brew from it?—Yes, but in their own country people drink their own beer generally.

7465. (*Professor Thorpe.*) I suppose importing beer into Bavaria would be something like carrying coals to Newcastle?—Yes.

7466. (*Mr. Cosmo Bonsor.*) It is only a question of law?—There is no restriction on that, I think.

7467. (*Chairman.*) Do you use sulphuric acid?—Yes.

7468. For dextrine you use nitric acid?—Yes.

7469. What is the source of your sulphuric acid?—We get it from Stettin, from one of the first chemical works in Germany. We have got it from Stettin for the last 30 years, ever since we started as a limited company.

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7470. Do you require a guarantee with it?—We always get it. I have brought five invoices as specimens for you to see, dated 1895, 1896, and 1900, all before the scare.

Acid guaranteed free from arsenic used in German glucose.

7471. You have yearly contracts, I believe?—Yes. These are the invoices. It is always stated to be free from arsenic, and we have got a factory—a small factory—in Baden, in the neighbourhood of Karlsruhe, where we also manufacture a small quantity of glucose. In order to be absolutely certain that we get pure sulphuric acid we get it sent from Stettin to that place, which means a journey through the whole of Germany, at a very considerable cost. This cost enhances the cost of sulphuric acid by 50 per cent. You will notice there, sir, one invoice embracing the freight, and from the note at the side you will see that the freight comes to half as much again as the sulphuric acid.

7472. Do you specify what the acid is to be?—Free from arsenic.

7473. You say here the acid is made from Sicilian brimstone?—That is so. We have been assured it is made from Sicilian brimstone.

7474. Does it mean purified acid?—It means made from sulphur imported from Sicily.

7475. At Stettin?—At Stettin.

but not tested by glucose makers until recently.

7476. (*Chairman.*) You formerly did not test the acid yourself?—We did not before, but since the epidemic we test every carboy of acid that comes into our place.

7477. Have you found any of it contaminated?—No.

7478. You have not had to reject any?—No, not sulphuric acid.

7479. Do you ever test your product too?—Always, every day, we test it not only when it is finished, but also in the progress of manufacture. The tests we use are Gutzeit and Marsh.

7480. Are Messrs. Julius Franks and Ohlman your agents in this country?—Yes, for the solid glucose.

7481. And you have no objection in your trade in giving the guarantees of purity to your customers?—Certainly not.

7482. I think you heard the last witness's evidence?—Yes.

7483. Do you agree with him as to the greater purity of purified pyrites acid over brimstone acid?—I do not know so much about that, but we guard ourselves by testing every carboy, and here is the result of one of our tests. Here is the Marsh tube. We also test all the sulphuric acid we get delivered, and there is not the slightest sign on this tube, as you see. This is made with 25 grammes.

7484. Is any supervision exercised by Government, or have they any control over the materials which you use, or is that left entirely to your own judgment?—That is left to us.

7485. Do you yourself make caramel?—Yes.

7486. And what is caramel used for?—For colouring purposes, mostly for beer, vinegar, and spirits.

Small use of liquid German glucose in England.

7487. You do not, I suppose, know whether your agents in England supply their sugars to other than brewers?—No, we do not know.

7488. Do you think that any large quantity is used for confectionery or jam-making?—The liquid glucose, yes. I have brought you a sample of that. (*Sample shown.*)

7489. Do you import a large quantity of liquid glucose into England?—Not very much. It comes to 500 or 600 tons in a year. It used to be much larger, but since the American competition came we cannot compete so well, because our articles are considerably dearer than others. People pay for their good quality.

7490. Is this liquid glucose much used on the Continent for making fruit syrups?—Enormously; a very much larger quantity than of dry glucose.

7491. (*Professor Thorpe.*) That glucose you have brought us is bleached now?—It is purified by charcoal.

Bleached by sulphurous acid.

7492. Is it not bleached with the use of sulphurous acid or sulphites?—To a very small extent. It runs out of the filters like this.

7493. Is there such an amount of sulphurous acid in it as precludes it from being used in brewing?—Certainly not.

7494. Are there many makers of these products in Germany?—Yes.

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7495. How does your firm compare, in point of magnitude, with others?—It is by a long way the largest.

7496. Do the other firms, too, send their products to England, do you know?—Not in later years, or to a very small extent only. We know it by statistics. I understand you to be only speaking of glucose now?

7497. Yes?—Nearly all the glucose which comes to this country comes from us.

7498. Has your attention been called to some statements as to the occurrence of arsenic in German-made glucose, on the authority of Dr. Ritter?—No.

7499. You have not heard, for example, that as far back as 1878 attention was called to the occurrence of arsenic in German-made glucose?—I remember it at the time, but it has never been proved. That was at the time when our glucose and all sorts of glucoses had been examined by the Reichsgesundheitsamt, in Berlin; but it has never been followed up nor mentioned since.

7500. Not in Germany?—Not in Germany.

7501. You are not aware that the matter was substantiated, as far as the French glucoses are concerned, by Professor Clouet?—I am not aware of it.

7502. It is news to you, then, that German glucose could contain arsenic?—It is.

7503. Are your agents in Liverpool?—No, in London.

German glucose used in English brewing

7504. Are they agents for any other makers of this material? Or are they general agents?—They may sell other glucoses—that I do not know. They are practically buyers from us, not what you call agents, people working on commission.

7505. They buy from you to resell?—Yes.

7506. They may very likely buy from other makers?—I should not think they buy from German makers, but they may buy American glucoses.

7507. Do they buy invert from you?—We do not make invert. These which I hand to you are the only glucoses we make. (*Samples shown the Commission.*)

7508. (*Mr. Cosmo Bonsor.*) You invoice to them, and not to the brewer?—We never sell to the brewer.

is consigned to agents, not to brewers direct.

7509. You really do not know the brewer?—We do not.

7510. What if they make a bad debt?—That is their business.

7511. Not your business?—No.

7512. (*Professor Thorpe.*) What amount of water does this glucose contain?—12 to 13 per cent.

7513. Is it fairly uniform in the proportion of water which it contains?—Yes, it is made of the same strength, almost exactly the same.

7514. The process of your manufacture is such that you ensure it shall contain 12 to 13 per cent.?—Yes, it is always weighed.

7515. Do you imagine yours is dryer than English made glucose?—I should say it is about the same.

7516. The other form of glucose also contains the same amount of water?—Slightly more.

7517. The white contains slightly more?—Slightly more, but that is only a question as to how it is asked for. We make glucose for export to Australia with a considerably less quantity of water in than that.

7518. What is the amount which this sample contains?—About 15 per cent.

7519. And that which you send to Australia—how dry is that?—About 11 per cent.

7520. (*Mr. Cosmo Bonsor.*) You state that you have no objection to giving a guarantee with your goods to the agents?—Certainly not.

7521. And you would have no objection to the Customs, I presume, being the check upon that guarantee?—Certainly not. I am assuming that the materials used by the different chemists for testing are absolutely pure, because it has very often been found and proved that the materials are not pure. We ourselves have been trying very hard to get the purest materials possible—for example, zinc for the Marsh test. We have examined the zinc and found—I do not know whether it could be called a trace—of arsenic, but there was a

little white circle round the tube, even with the purest materials we could obtain over there.

7522. Has it ever come to your knowledge that saccharine has been mixed with glucose for the purpose of giving added sweetness to it?—We have never done so.

7523. Has it come to your knowledge?—It has come to my knowledge that it has been done in this country. In Germany the use of saccharine has been altogether prohibited since about twelve months ago.

7524. The use of saccharine has?—Yes, except that it can only be bought from pharmaceutical chemists; it cannot be bought in bulk. I may mention that the samples I have brought are not made up for the Commission. They are average trade samples.

7525. (*Dr. Whitelegge.*) Do you use only potato starch?—Only potato starch.

7526. And from that you make both solid and liquid glucose?—Yes.

7527. Will you tell us, briefly, what is the distinction between the two?—Do you mean between the solid and the liquid?

7528. Yes?—Liquid glucose is the first stage. Liquid glucose is not boiled so far that it crystallises. It is a between product.

7529. But by further treatment liquid glucose would yield solid?—Yes, it would turn solid. Liquid glucose may turn solid afterwards if by any mistake it is carried a little too far.

7530. Liquid glucose is cheaper?—No; on the contrary, it is rather dearer, because the package is dearer. It is supplied in big casks, and they are expensive. Also, in consistency it is very thick. Here is the strongest consistency.

7631. (*Professor Thorpe.*) What is the actual amount of sugar in this sample?—I should say about 40 per cent.

7532. (*Dr. Whitelegge.*) Are both used in brewing?—The liquid form is not used in this country, to my knowledge, for brewing, but it is used largely in America. We used to ship large quantities to America in former times, before the maize glucose was invented, and I have been informed it has been used for brewers mostly.

7533. Would other kinds be used in wine?—You could not use liquid glucose in wine.

7534. The glucose used in brewing in North Germany is the solid?—It is solid.

7535. Is that used in brewing beer similar to Bavarian beer?—It is more used for the top fermentation beer.

7536. Would it not be suitable for the other?—I do not know, but I believe it would.

7537. Is there any Government inspection of your factory in Germany?—Oh, yes.

7538. Any special inspection by reason of glucose being made?—No.

7539. Simply the ordinary application of a Factory Act?—That is it.

7540. You told us that you have found no arsenic in the sulphuric acid?—No.

7541. Does that mean absolute freedom from arsenic?—Absolute freedom.

7542. Not even traces have been found?—Not even traces.

7543. You limited your answer to the sulphuric acid. May we take it that in other acid arsenic has been found? Had you in mind the discovery of other kinds?—Hydrochloric and nitric. I have not examined them.

7544. You have not found arsenic in any acids?—In hydrochloric, to my knowledge, small traces of arsenic have been found.

7545. Was that supplied on a guarantee in the same way?—Only purified hydrochloric acid.

7546. It was not said to be free from arsenic?—No; because that is used for the purification and cleaning of charcoal. Will you let me say a few more words? It has been stated that potato starch, in its conversion into glucose, produces a deleterious substance called gallisin, which is an unfermentable matter. I wanted to hand in a paper to show it is untrue, and that it has been proved by eminent chemists and physiologists that it is an absolutely harmless substance. I have brought here a paper and literature dealing with this subject.

7547. (*Chairman.*) Do you say your manufacture is exclusively from starch of your own making?—Yes.

Potato starch invariably used in German glucose.

7548. We have heard from other makers of glucose that there is a danger in using some of these meals; that you do get nitrogenous compounds which are offensive, if not dangerous?—Yes. Well, we are excluded from using anything but potato starch, on account of the very high duty in Germany on other imported starches, like tapioca, rice, and sago flour. There is a duty of about £8 or £9 a ton, which renders it prohibitive for us to use these starches.

7549. Is there not very considerable difficulty in freeing potato starch from other matters?—It is not nearly as difficult as from maize, but by careful manufacture it is made as pure as you see it there.

7550. Made pure by purely mechanical processes such as grinding and washing?—Yes, grinding and washing.

7551. If not purified, I think potato starch would when treated, give origin to a considerable amount of offensive matter?—I should think so. I do not think anybody would use potato starch for glucose making without it was cleaned. They could not very well. The potato water has to be got out of the potato first before the starch settles down.

7552. (*Professor Thorpe.*) What is the particular mode of treatment which enables you to get this white as compared with greyish colour?—The white is the original product, and the yellowish colour is made to people's fancy. It is simply a matter of fancy. Most people in this country prefer the yellow to the white. In Germany we sell the white. We also send white to this country, but yellow to a greater extent. The yellow is not a second quality; that is, it is the same pure quality as the white, only treated differently.

7553. But containing a slightly different percentage of water?—Slightly less. That is only a matter of detail. If they would like to have it stronger and pay a higher price we should be pleased to do it.

Potato starch contains no gluten.

7554. Could you tell us whether it would be possible to determine that that was made from farina or from pure tapioca, or whether it was made from pearl starch? Would not pearl starch and farina yield identical products?—I think in pearl starch—which I understand is maize starch—you might find a small percentage of converted gluten by the aid of acid, and you would always find a trace of phosphoric acid in sugar made from maize too, as far as I know.

7555. Is there no phosphoric acid in this?—No. In my experience potato and farina starches are the purest you can have. It does not contain gluten, which maize starch does.

7556. You think it might be possible to differentiate between the various glucoses?—I never tried it. It might be possible. But I shall be pleased to let you know. I will ask our chemist to make experiments; I daresay he can let me know.*

7557. I should personally like to know how it might be possible to detect the origin of any particular form of glucose. It would be very useful to know.

(*Mr. Cosmo Bonsor.*) It would be very useful to detect the origin of beer in the same way.

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* *Note by Witness.*—Our chemist, whom I have consulted, writes that he considers it is not possible with any claim to absolute accuracy to find out by analysis whether glucose was made from farina, maize, starch, tapioca, or sago, or any other flours.

Mr. Walter W. Berry, called; and Examined.

Mr. W. W. Berry.

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7558. (*Chairman.*) You have, I think, had large experience in the growing of hops?—I have grown hops all my life.

7559. On a large scale?—Fairly large, yes.

7560. (*Mr. Cosmo Bonsor.*) You do grow hops, and you also sell other growers' hops?—Yes, but I only sell the hops which I am interested in. Part of my business is my own and part of my mother's. I sell hops in my own name.

7561. You manage other people's hops?—No; I am called in for advice professionally, but I do not control any other growths but those of my own family.

7562. (*Chairman.*) Perhaps you will have the kindness to inform the Commission upon the systems in use in growing hops, so far as it bears upon this question. I do not think we need go into the preparation of the land, or the planting of the hops, but rather the growth of the hop each year?—Your desire, I understand, is to know in what way chemicals are used in the growth?

Hop insecticides, soft soap and quassia.

7563. At what time of the year do you generally commence spraying with insecticides; when do you commence washing the hops?—I shall be commencing to-morrow, so it will be fairly early in the season. It is on the appearance of certain insects that we commence to spray, to check the damage as early as possible. At the present time the bines are just shooting out of the ground, and the turnip flea has commenced to attack. The season being a late one, if the turnip fleas are persistent we get only a small quantity of bine. So we are endeavouring to check the spread of the insect. We are using a strong solution of soft soap and quassia, just to make the plant nasty, so that the insect will not eat it.

7564. Is the turnip flea the same beetle as attacks the turnip plant?—Yes.

7565. That is when the hops come out of the ground?—They attack the bines as soon as they see them.

7566. (*Dr. Whitelegge.*) Not later?—Yes; it is troublesome now. They do not blacken the plant as the aphis does, but they retard the growth.

7567. Will you tell us your address?—Gushmere Court, near Faversham.

7568. (*Chairman.*) At a later stage, when the hops get up, aphis is apt to appear?—Yes, and we spray vigorously to get rid of the aphis during the earlier stages, to keep the plant free, that it may grow freely, and to prevent the cones from getting damaged from the filth that arises from the aphis.

7569. What is used for spraying hops to get rid of aphis?—The principal ingredient is good quality soft soap. In all the washes that are used, soft soap is largely employed. Extract of quassia chip is also used to make the plant bitter, so that the young insects which we miss killing may not thrive on the plant. We find that although we kill the aphis, before it is dead, young ones are born, and we might miss the young ones. But if the plant is made bitter the little insects do not thrive on the plant. Clean quassia chip is used for that purpose, simply to make the plant bitter.

and other substances.

7570. Do you use anything else?—Great numbers of things are used. Many chemists are producing various things, but they are only used experimentally. I have used a wash called Spimo, which consists very largely of soft soap. There is also some quassia, and there may be some other ingredients of which I have no knowledge. But in use that is practically like my own. Not being a chemist, I cannot say what the other ingredients may be.

Paris green not applied to hops.

7571. So far as you know, chemical substances, such as Paris green, are not used?—Never used on hops; at least, I have never known it used. Paris green is only used on fruit, where altogether other kinds of insects have to be dealt with. It would be a great waste and an unnecessary expense to use Paris green in a hop garden.

7572. Is sulphur never used?—Sulphur is largely used. Dissolved sulphur is used in the wash, in quantities of about three or four pounds of dissolved sulphur to an acre of hops.

7573. Do you know what dissolved sulphur is?—Liver of sulphur.

7574. Is it dissolved with the soft soap?—No.

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7575. Is it a soft soap solution?—No. What I call dissolved sulphur is this. We receive it as liver of sulphur, and that, in water, soon becomes quite liquid. But we do not attempt to dissolve ordinary sulphur ourselves.

Use of sulphur in hop growi

7576. You would have a difficulty, I think?—We should have a difficulty in perfectly dissolving it, but I have assisted in some experiments to try and get it dissolved by the use of lime and acid; that is, to try and make a solution from the flowers of sulphur, but it is very difficult, and the results have not been very satisfactory.

7577. (*Professor Thorpe.*) You make your own solution of soft soap?—Yes, we buy soft soap by the ton and boil it, and add to that the liquor which we get from steeping quassia chip in moderately hot water for 24 hours.

7578. You never tried the effect of adding flowers of sulphur to the boiling soft soap solution, did you?—We put it in, but I have not done it for years. If we get an early attack of mildew in the hops, and when one washing has not affected it, we have tried this, but it was only done as an experiment, and we got no beneficial results.

7579. What do you think it is in the soft soap which protects the plant?—The alkali.

7580. You could use it as pure alkali just as well as in soap?—Yes. It is possible, but with the soap all the machinery works well. If you simply had alkali and water the machinery would not work well.

to destroy mould.

7581. (*Chairman.*) In the first attack of the aphis sulphur is very little used?—Yes. It is not used for aphis, it is only used for mould. And I would explain that, in the early days, when little was known by hop-growers of the disadvantages or advantages of sulphur, it was used carelessly. But to-day it is used carefully, and our system is to so treat the plant in its early stages as to keep it healthy, and so that the crop is clean. It is years since I have seen any quantity of mildew in the cones, and the brewers with whom we deal beg of us not to use sulphur when the cones are produced, but only in the earlier stages. It is impossible for sulphur very largely to get on to the plant at all.

Sulphur during ea growth

7582. Therefore, I understand from you that it is almost impossible for any amount of sulphur to be present upon the flower of the hop?—Yes.

7583. Then it is not, as I think there is a common impression, dusted with dry preparations containing sulphur?—They are in certain instances. If a man sees his crop going he will make great effort to save it. But it is not necessary to use it in later stages.

and whe hop in flo

7584. But when you get an attack of mildew when the bine is in flower, is it not the case that powders are used for sprinkling?—Yes, they are vigorously sulphured then. A man will make a great effort to avoid losing his crop, and as a last resort he will sulphur it. It used to be the system to do it always, to do it for the purposes of colour. But brewers have, and I think very wisely, declared that they will not attend so much to colour as they have done. Therefore we produce a much more natural article, and sulphur has dropped out of use.

7585. Still, in those cases where the burr is vigorously sulphured there might be a certain amount of sulphur powder remaining in the burr when it is gathered?—Yes, there might be in such a case, but those cases are very infrequent to what they used to be. I would like to explain the nature of the sulphur we use for this purpose. We use the best flowers of sulphur, sublimated Sicilian sulphurs. Other sulphurs it is impossible to use; they are not sufficiently light.

7586. The Kent farmer would not specify anything further than flowers of sulphur?—Yes; he would have one of two or three makes only, because such flowers of sulphur as are used for chemical purposes are not good for us, they are not sufficiently light. Hops grow ten to twenty feet high; our machine passes under the hops, and it is like a winnowing machine which winnows chaff out of corn. It winnows the sulphur into the air.

7587. The farmer would perhaps specify it should be in an extremely finely divided condition, but he does

not specify that it should be of any guaranteed purity?—No; the question has never been raised until this season.

7588. Therefore, as you said, he would use Sicilian sulphur?—Yes.

7589. But, so far as you know, he probably would use sulphur obtained from the refuse of gas works?—No; and for this reason. We buy sulphur for dusting the plant with, and for purposes of stimulating a plant which is flagging. We also buy what is called rolled brimstone. That is purified rock brimstone, which comes from the Mediterranean for bleaching purposes in the kilns. We have always known that it was necessary to have the purest and best quality we could get for use in the kilns, not because we had any chemical knowledge as to possibility of contamination, but because, in producing such a valuable article as good hop, we have felt it was necessary to buy the best, inasmuch as a few shillings a ton is the only difference in price between the ordinary and the best. I have only known hop farmers buy the best. The best sulphur is the Sicilian, and the firm who supply seven-tenths of the whole are Brandram Brothers. There are two or three others, whose sulphur I believe is equally good.

7590. (*Professor Thorpe.*) Are this firm importers of sulphur?—I do not know anything about their business, except that they have a large business in sulphur. Whether they import it or buy it of shippers, I do not know.

7591. Do they deal exclusively in sulphur?—No; they manufacture white lead, and so on.

7592. Where is their place?—At Rotherhithe. When I was called upon to give evidence, I asked those with whom I trade if they would give me information, and they replied that the sulphur and soap are absolutely free from arsenic. In one case the man replied that he believed it always had been absolutely free from arsenic.

7593. (*Chairman.*) As a matter of fact, probably they had never looked for it?—I was going to suggest they believed it always had been, and this year they are sampling everything they send out, and find that there is absolute freedom from arsenic.

7594. You are able, of your own knowledge, to tell us that the sulphuring of hops with powdered sulphur only occurs in exceptional years to any extent?—Yes; and in an exceptional acre in a crop. It is an expensive operation, and brewers object to it, and therefore it is not done if it can be avoided. The brewers have said, "If you have any necessity to sulphur any portion of your crop, ear-mark that, that we may know." And very great care is taken.

7595. You have a great experience of methods of gathering and curing hops?—Yes.

7596. And you have already told us that best brimstone is used on the kilns for bleaching?—Yes.

7597. Is that largely or generally used?—Yes. But the quantity of sulphur used is very small; it is only necessary to use very little. I have used 2lbs. of sulphur to a cwt. of hops. It is burnt in a pan.

7598. It is not thrown into the fire that is used at the bottom of the hop kilns?—I have seen it done in that way, but I do not adopt that plan myself; it is very wasteful, and you do not get rid of it. My plan is to have a pan into which the necessary quantity of sulphur is placed, and when the hops are first put on the kiln, full of natural moisture, this sulphur is burnt underneath it for two hours. Then there is no necessity for anything further. If you put the brimstone on the fire, it melts and all runs through on to the ashes below. When the manager of the kilns finds he is getting more heat than he wants, he puts ashes on to check the heat, and the sulphur which is not consumed he puts up, and there is constantly some sulphur. We absolutely burn out what we require to use.

7599. You take your pan away?—You cannot do that when it is burning.

7600. What fuel do you use?—We use the best Welsh anthracite. There again the best is the cheapest, because it is free from waste. We can burn 100 tons of best Welsh anthracite with less than 1 per cent. of ash.

7601. I am speaking of your own district generally?—I know of nothing being used in my district but anthracite from the best Welsh collieries. Years ago we used gas coke, but during my time never.

7602. Speaking of the district generally, gas coke is seldom used?—I have not heard of it being used in my own district, but I have heard that it is used in Worcestershire. Speaking generally, I have no knowledge of it.

7603. The fumes of the fuel pass through the hops?—Yes; hence the necessity of good anthracite coal.

7604. During all your experience, has anthracite coal been used, or do you remember the time when hop kilns were worked with charcoal?—We use a little charcoal now, but charcoal is used for hastening up the fire. For instance, if the heat is flagging, or if we get the hop discoloured by the change of wind and the draught is not regular, by putting on a few pounds of charcoal it helps to kindle the anthracite and keep the heat up steadily. A few bushels of charcoal are used in each kiln each season, but only for regulating the fire; not as coal is used, but only to assist the coal.

7605. Have you any views whether there should be any alterations made in the practice of either washing or cleaning hops or drying them?—I think not. It is impossible for any sulphur to get into the hops in any appreciable quantity. I also think that the material we use is so thoroughly pure from any contamination that it is impossible for any damage to accrue from hops. I have heard that arsenic has been found in hops, but I have also known of hundreds of samples being carefully tested by an expert without any trace of arsenic being found. I can only imagine the possibility of any trace of arsenic where a very low class of gas refuse has been used as fuel, and the fumes have left any kind of soot—what I understand as soot, or whatever it may be—in the hops. I can imagine such a case, but the system of hop growing on a large scale is such that I think contamination from arsenic is impossible.

7606. I suppose to use any gas coke would be likely to spoil the aroma of the hops, would it not?—I have no knowledge about that. I have never used gas coke. We have always been able to produce a satisfactory article, one that has given satisfaction to the consumer, by the use of the best anthracite coal. I have adopted that course, and I have never attempted to use gas coke. If coal was at famine prices and coke available we might have used it, but there has never been the necessity.

7607. As far as your knowledge goes even the small growers do not use gas coke, do they?—No. The vessels come in with coal for the large growers, and the merchants who supply us with 100 tons will supply the small growers with one or two tons. The small grower gets exactly the same article as we get. It would not be of any advantage. Even if the smaller growers wanted cheap coal it would not be of any advantage to them.

7608. In your opinion it is unnecessary to take any precautions in the manufacture of hops for the brewer, but you admit yourself that traces of arsenic have been found in hops?—I have heard so, but I do not believe it. When I say I do not believe it, I would not dispute any evidence that has been brought before the Commission, but I think I should have known if it had been conclusively proved that any hops had been found with arsenic in them. For instance, the Hop Trade Association in London do not know of any instance where arsenic has been traced to hops.

7609. It is only lately that it has been looked for?—That is so.

7610. I suppose you would be prepared to say it would be probable that in those cases in which it had been found it might have come from hops that had been sprinkled with powder for the sake of mould?—I do not think that. If it is possible at all it is from using very bad fuel. I do not think it is possible in the growth of the hop, because these heavy, dirty sulphurs could not be got up on to the hops. We only use sulphurs which are absolutely pure—like this sublimated sulphur.

7611. Arsenic is sublimated with sulphur—it is all sublimated together?—Yes, if there is any; I am not a chemist, but what I look upon as the residue would, to my mind, contain the dangerous matter, but it may not be so.

7612. You think that if there is a risk of arsenic it is from the use of improper fuel?—Yes. I think there is no risk in any other way.

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Gas coke seldom used to dry hops.

Charcoal used, mixed with coal.

Arsenic in hops.

Any arsenic in hops would come from fuel.

Mr. W. W. Berry.
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7615. (*Professor Thorpe.*) Does any quassia get upon the hops?—I do not say it never does, but not often. It is used in the earlier stages.

7614. There is no idea in using quassia that it also adds to the bitterness of the hops, is there?—No. You would not find a good planter wishing to improve the quality of his hops by the addition of anything.

7615. (*Chairman.*) But as a matter of fact, it is very seldom that sulphur is ever used after the burr appears?—Only in very exceptional cases. I have known a case where it has been necessary, but only where the hops have been more or less neglected in the earlier stages.

7616. (*Professor Thorpe.*) Have attempts been made to follow the same methods of using insecticides in hop growing as in grape vine growing?—Only in respect to mildew. I have always thought there was something to be learnt from the vine grower on the question of mildew, because mildew is a most serious trouble to the grower, but the insecticides, I believe, are so different. What we require for our aphis is such a simple remedy and so cheap and easy to be applied, that we do not want to learn from anyone. In the case of sulphur, however, it is different. We have endeavoured to get some information with regard to the methods of applying sulphur. But I do not know any improvement on what we now use—on the finest flowers of sulphur.

7617. In France they largely use what are called the sulpho-carbonates; that is an alkaline solution made by burning together bisulphide of carbon and soda or bisulphide of carbon and lime. It is very soluble, and a very little goes a long way. Has that to your knowledge been used in England?—Yes, I think there are two or three people who are now putting up a compound wash which is used by the smaller growers who do not want to build up the necessary plant for producing the wash such as I use. They buy a cask, or even a gallon of this particular kind of wash, which contains a dissolved sulphur. We know because of the very foul smell when the bung is taken out. It is used to a small extent, but only to a small extent. It may be that we have something to learn in that direction.

Tobacco extract as insecticide for hops.

7618. Is offal tobacco extract ever used by you as an insecticide?—It would only be used very early in the season, and in very persistent attacks. Nicotine is, of course, one of the best things to use to destroy insect life, but it is very costly as compared with soft soap and quassia. Where you have a plant to manipulate the soft soap and quassia there is nothing so cheap.

7619. I am not speaking of the direct application of nicotine so much as the mere infusion of waste tobacco—what is called offal tobacco, which is cheap enough. The Customs are only too glad if you will take it away?—I have never had it offered to me, or I might have experimented with it. I have no knowledge at the present time of tobacco juice being used in hop gardens at all, but it used to be used.

7620. You are not aware that the Board of Customs gives facilities to agriculturists and people making such things as sheep washes for the use of this product?—I know that every opportunity is given in bond for dealing with this stuff. Chemists have told me that there are some fruit tree washes, and washes which are used under glass, and so on, where it is used, but I do not know of its being used in the hop garden.

7621. The use of a product like that would have the advantage of entirely preventing the possibility of the access of arsenic?—Quite so.

7622. Are foreign hops treated very much in the same way as you have described in the case of English hops?—I have never had time to travel during the hop season. I had to attend to my own crop, and I, therefore, have absolutely no knowledge on that point.

7623. You have no knowledge of the kind of insecticide which is used in foreign countries in connection with hops?—No.

7624. What I want to get at is whether foreign hops are more liable to contain arsenic than English-grown hops?—I should be glad to hear that they were, but I should not like to say so, because I have no knowledge.

7625. (*Mr. Cosmo Bonsor.*) Would you tell the Commission how much on an average it costs to cultivate an acre of hops?—£50.

7626. That includes rent, rates, tithe—in fact everything from the commencement up to the completion of the curing of the hops?—£50 an acre. If I get over £50 an acre for the crop there is a profit; if I get less, there is a loss. Some seasons it will cost more, and for this reason: if we grow a large crop that large crop costs a great deal more to pick and cure and get to London than a small crop at a higher price per cwt.

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7627. How much of the £50 an acre would you put down to labour: have you ever divided it?—I am afraid I could not give you those figures. If it would be of interest to you I would have them looked up. Labour would be by far the largest item. I should say roughly that £30 out of the £50 would be for labour, probably a little more than that even.

7628. By the time the hop reaches maturity it is more or less an artificial product?—It is unfortunate if it is. It is never so good as when it grows naturally. We have, however, to resort to artificial means to get hops at all in bad seasons. If we did not destroy the insects, the insects would destroy the hops.

7629. I believe you grow several sorts of hops?—We grow Golding hops and Golding hops only. But the Golding hop is in three sections: there is the old Golding which hangs later on the poles than any other varieties, supposing it is healthy, but there is an early Golding hop which is practically the same hop, but it ripens somewhat earlier. That was raised from one plant which was grown in the garden and cultivated on and on. It is called the Brambling Golding, as it originated in the Parish of Brambling. It is the same hop but it ripens earlier. We have an intermediate "sport" now which we call Cobb's variety. I grow no other varieties than those three.

7630. What is the object of growing three different sorts of hops: is it for kiln purposes?—I cannot admit there are three different sorts of hops.

7631. Then three hops that come to maturity at different times?—For this reason. We have to get labour from London and elsewhere, from the large towns, and it would be impossible from a commercial point of view to house all these people for 7 or 8 days only to pick the crop while it is at its best. We desire to pick our hops during three or four weeks, and we get the earlier section of the Golding hop, and the intermediate section, and the later section by careful selection. We have got the best variety of hop now, so that it will ripen in three stages. We can pick them now in about 3 weeks.

7632. (*Dr. Whitelegge.*) Are hops always dried by exposing them to the fumes of the fuel: is there any other method in use?—No.

7633. For what purpose is the sulphur used at this stage?—I am not competent to tell you the reason why, but sulphur, to the extent of about 20 or 25 lbs. to the acre, is scattered over the plants by means of the appliances I have explained, and it has the effect of stimulating a tired plant. For instance, if from atmospheric reasons, from very great heat and drought, a plant is flagging, it, so to speak, breathes the fumes of the sulphur, which is of great assistance to it.

Brewers require hops bleached by sulphur.

7634. I mean rather the sulphur used in the kilning process—the sulphur that is burnt?—The sulphur that is burnt is, I think, used for the purposes of colour. It is for bleaching purposes.

7635. Is it used with all hops?—I have known experiments made where hops have been left unsulphured, and I have known the brewers to request that you will send them a few packages of absolutely unsulphured hops; but we have never known the order to be repeated.

7636. Does it alter the hop in any other respect except in colour?—Not the slightest; but when the hop is quite green and begins to dry, the sulphur fumes passing through give the hops the desired colour.

7637. Does that affect the colour of the beer?—I think not.

7638. Is it anything but prejudice on the part of the brewer?—I should imagine it is more or less a prejudice on the part of the consumer.

7639. But if so, it is an universal prejudice?—Yes.

Hop traders have refused to guarantee hops as free from arsenic.

7640. Have you been asked for any guarantee with the hops you supply to brewers?—I understand that brewers have asked for a guarantee from the hop trade. The hop trade is so convinced that there is nothing in the hops, and that it is impossible to get anything wrong in them, that they have declined to listen to any such proposal.

. W. W. Berry. — May 1901.

7641. (*Professor Thorpe.*) Even although they use arsenical coke?—We do not know of any arsenical coke being used. We only use anthracite coal, as far as I know.

7642. But you told us that the trade might occasionally use gas coke?—I say if they did there might be a danger, but I can imagine no danger in any other direction.

7643. But there is some danger as there is in the case of malt?—Quite so.

7644. If maltsters are required to give a guarantee, why should not hop growers be required to do so?—Well!

7645. (*Dr. Whitelegge.*) Would hop growers be prepared to give the same sort of guarantee which has been suggested in the case of maltsters?—I think they would resent it, and say "Why should we give a guarantee, we only use these things?" If you ask me personally my own feeling, I may say that I should be prepared to guarantee my article.

7646. As free from arsenic?—Yes.

7647. You are prepared to guarantee that you use only anthracite coal and Sicilian sulphur?—Yes.

7648. And your sulphur you would be willing to give up if the brewers would consent?—I should be glad to save the expense.

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7649. An earlier witness has given us the results of analyses of hops. Bearing upon an answer which you just now gave that it was unknown to the trade that small quantities of arsenic had been found in hops, we have heard from one of the witnesses who has been called before us that a number of analyses of hops have been made in which small quantities of arsenic have been found?—Indeed! I should imagine that the samples could not have come from that part of the country which I have most knowledge of.

7650. What you have told us about the treatment of hops in growth and manufacture applies generally, I suppose, to other districts besides Kent?—Yes, I think so.

7651. You have told us that in Worcestershire it probably is the practice to use coke instead of anthracite?—Excuse me, I do not think I put it in that way. When the question of arsenic was raised I heard of a sample of hops which it was suggested had been dried with gas refuse, small coke. That, I understood, was a Worcestershire sample. But I have no knowledge of coke ever being used anywhere else.

7652. Your impression is that anthracite is principally used, even in Worcestershire?—Yes.

7653. Are there any other important centres except Kent and Worcestershire?—Yes. A good many hops are grown in Hampshire and Sussex, but the process is the same. Except in but a very few cases, I am certain that nothing but the very best anthracite coal is ever used. It is so easily detected if you get any other coal. If other than Welsh coal were used a farmer would know it directly he went into his kiln from the bad smell. A farmer dare not have a bad smell to his hops. If a brewer put his nose to the hops and found there was a bad smell to them he would not buy them. Of necessity we are bound to use the best coal.

7654. I suppose the curing is done on a small scale often; a small grower would cure his own hops?—Yes. There may be a man who has one kiln; in my own case I have thirty kilns, but the process in the one kiln is exactly the same as in my thirty kilns. I think the small grower puts his hops on the market as pure as I do. He buys his coal and sulphur from the same people.

7655. And you think he may be equally trusted to buy only anthracite coal and use pure sulphur?—I think so. He would have a difficulty in getting anything else.

7656. (*Chairman.*) I do not think you quite appreciate the difficulty. Where would the small grower buy his sulphur?—He would buy his sulphur one cask at a time where I buy ten tons at a time.

Mr. W. W. Berry. 10 May 1901.

7657. He would probably buy it from a small dealer?—No, I think not. This business is the business of my district, and the sulphur comes down perhaps in 50 or 100 tons at a time to the town. I get my quantity, whatever I want, and the small man gets what he wants. He cannot get anything else. It is kept in stock. What is necessary for large people is necessary for small people, and they have no option. The small people must have the same thing as we have.

7658. Then you think there would be no difficulty in a hop grower obtaining from the sulphur seller sulphur which was pure?—That is my opinion. I have asked all the men I have dealt with if they think the sulphur is pure, and they have told me that they will guarantee that everything shall be pure. They say they believe it is always pure.

Hop growers' sulphur is guaranteed free from arsenic.

7659. But do you think in the future there will be any difficulty in the hop grower obtaining from the firm from which he purchases his sulphur a guarantee of purity?—I have in my hand guarantees from the people from whom I buy, and I have already bought on that guarantee.

7660. What do they guarantee?—I have here a letter from Brandram Brothers and Co., Limited, manufacturers of white lead, and vermilion colour grinders, refiners of saltpetre, brimstone, etc., etc. They write from Rotherhithe, under date of April 15th, 1901, as follows:—"Mr. H. S. Tett, Faversham. Dear Sir,—Enclosed we beg to hand you a supply of circulars, re our sulphur products, guaranteeing same free from arsenic, for distribution amongst your customers. Should the supply be insufficient we shall be happy to send you more. Yours, very truly, Brandram Bros. and Co., Ld." With that there is a printed notice, which is as follows:—"Notice. To Hop Growers, Chemists, and others. In consequence of the recent trouble caused by the presence of arsenic in beer, Messrs. Brandram Bros. and Co. Limited, of Rotherhithe, London, S.E., beg to state that their 'Brandram's' Pure Sublimated Flowers of Sulphur, 'Brandram's' Finest Virgin Roll Brimstone, "Brandram's' Finest Hop Sulphur, 'Brandram's' Finest Powdered Sulphur Vivum, have been analysed by the eminent Analytical Chemists, Messrs. E. F. Teschemacher and J. Denham Smith, of 1, Aubert Park, Highbury, N., and pronounced by them to be 'free from arsenic.'" That is the notice. The letter says that they guarantee their products all free from arsenic. This is from the principal firm, and I have similar letters from two or three others.

7661. So that in future you think there would be no difficulty for a hop grower getting a guarantee of the purity of the sulphur he uses if he asks for it?—That is so. The fact that that class of sulphur is being sent down to the hop districts would, I believe, make it very difficult for any man to get any other variety than that.

7662. (*Dr. Whitelegge.*) Would you go so far as to say that it would be wrong to use any other fuel than anthracite and possibly charcoal?—I do not know that it would be wrong, but my successes have been built up by using the very best fuel I can get. I buy the best of everything. The difference between an inferior article and the best is usually only a few shillings. I think £10 a year would make all the difference between buying the best anthracite or the second best. The railway carriage from South Wales is the same. It is only a question of prime cost on the bank, whether it comes out of No. 1 or No. 2 vein.

Anthracite of different qualities.

7663. You do not consider it right to use gas coke?—No, I do not. There is no saving in using it. If the kilns are properly constructed, and the coal is judiciously handled, best anthracite coal is as cheap as coke. The better the quality of the coal the more economical it is.

SIXTEENTH DAY.

WESTMINSTER PALACE HOTEL.

Monday, 13*th May*, 1901.

PRESENT:

The Right Hon. Lord KELVIN (in the Chair).

Sir WILLIAM CHURCH.
Prof. THORPE.
Mr. COSMO BONSOR.
Dr. WHITELEGGE.

Dr. BUCHANAN, *Secretary*.

Mr. HUGH BAIRD, called; and Examined.

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7664. (*Chairman.*) You are a large maltster in Scotland?—Yes.

7665. Can you inform the Commission what fuel is used in your maltings?—We use nothing but anthracite coal. We have drawn it from one pit from ten to twelve years, namely, the Gartshore Pit, Stirlingshire.

Anthracite hand-picked at collieries

7666. Do you select the fuel in any way, or simply take what comes from the mines?—The fuel that is sent to us has been passed over screens and then through meshes to get it of one size. At the foot of these screens boys and women watch for any piece that they think doubtful. Then when it comes into our possession we have it all riddled before utilising it in

and riddled at maltsters.

any of our furnaces.

7667. A piece looking doubtful in what respect?—Sometimes they may think a piece is not perfectly pure—a dull piece, and then it is thrown to one side.

7668. Those pieces are all rejected by you?—They do not come to us at all. They are rejected at the coal pit.

7669. What length of time is your malt kept on the kiln?—From four and a half to five days.

7670. What steps are taken to prevent accumulation of dust and deposit—the products of combustion?—All our beams and our plates are brushed down once a week, and oftener if required.

7671. And is the floor bared and swept occasionally? Below the kilns it is swept out regularly, sometimes every day, but always twice or three times a week.

7672. That is the bottom of the kiln. But what about the floor on which the malt dries?—That is cleaned every time the kiln is taken off.

7673. Every time the malt is taken off the floor and sides of the kiln are brushed?—The kiln floor is brushed clean, but I referred prior to that to the floor below the kiln, where the dust may come down through the holes on to the bottom floor.

All brewer's malt brushed.

7674. At what stages of malting, and how often, is your malt screened and brushed?—We clean our malts twice as they leave the kiln before they go into the deposit rooms, and then it is cleaned once, and sometimes twice, over the machinery before it goes to the consumer.

7675. In the case of malt going to breweries would all grades of malt receive the same amount of brushing?—All malts we send to our customers do receive the same amount of brushing.

Pneumatic malting not as satisfactory for brewers as kiln

7676. Have you had experience of pneumatic malting?—We have.

7677. Do you use it?—We have got one drum, and we work it for distillers' malt, but not for brewers' purposes, because we do not approve of it. We do not think it makes the high-class malt we require to send out to brewers.

7678. In what respect is the malt inferior?—We have found a difficulty in getting it rid of the moisture. We cannot get our malt what we call freed properly.

7679. In the pneumatic malting, is not the air drawn through several cylinders or drums which rotate?—Yes.

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7680. So as to shake the malt?—The malt falls over gradually.

7681. But you find you cannot get the malt properly dried that way?—We do not dry it in a drum at all. Some people do dry it in a drum, but not in the same drums used to germinate the malt.

7682. In the pneumatic malting the drying would not necessarily take place in drums, though germination does?—I believe some drums are constructed for drying, but I have never seen them.

7683. In "pneumatic malting," as generally understood, then, the drying would be done on the same plan as ordinary kiln drying?—We do so. We dry it the same way in an open kiln.

In pneumatic malting final drying is on the kiln.

7684. Why is it that you cannot dry it so well in drums?—We have no experience of drying malt in a drum, and from what I have heard, people do not like it.

7685. What objection do you understand is made to it?—I do not think malt can be cured unless heat passes through it, and in the pneumatic drying drum you can only pass the heat from the exterior, or through the pipes running through it, and it does not get the same amount of heat applied to it that it would get in an ordinary kiln.

7686. In the pneumatic drying drum the drum is heated, and heated air is drawn through?—Yes.

German malt not exposed to fumes

7687. We have been told there are various processes by which the malt can be kiln dried without being exposed to the fumes of the fire. We have been told that in some of the chief beer factories of Germany the malt in drying is not exposed to the fumes of the fire at all?—There are such kilns in Germany.

7688. Have you any experience or knowledge of those kilns?—I have not seen them at work.

but would not suit English beer.

7689. That malt makes German beer which is esteemed for some qualities?—Of course, German beer is treated in an entirely different manner to home beers; the mashing process is quite different, and, therefore, that malt, although it might suit their purposes, would not suit home-brewed beer at all.

7690. Why do you think malt that has been dried without exposure to the fumes of the fire should, if properly dried, not give as good beer?—I see no reason why it should not, if it is properly dried; but it is a question if it is properly dried.

Flavour of fumes essential

7691. We have been told that part of the flavour that is required by the users of beer in this country depends on the exposure of the malt to the fumes of the coal, and that if the malt was not exposed to the fumes of the coal, it would be impossible to get the flavour that is liked?—You cannot get the flavour if the fumes from the fuel do not go through the malt.

7692. What part of the fumes is it that give the flavour?—I think it is more because on account of the fumes the heat is properly applied to the malt, and gets thoroughly through the malt.

7693. Then, if it were hot air instead of hot fumes, the result, so far as drying, would be thoroughly the same?—It might be, but I question it.

7694. Have you reason to believe that the carbonic oxide or the carbonic acid, or anything else in the fumes is essential to the flavour of the malt?—I should not like to answer that.

7695. Do you see any reason why that malt should not be kiln-dried purely by hot air, supposing the process could be carried out, and produce a malt quite as good as that produced by the present process?—I do not think it could, as far as my judgment goes.

7696. Suppose the hot air gets through it just as much as the fumes of the fire?—There is something that must come from the fuel which gives a flavour to the malt that we cannot get with hot air.

7697. Very different kinds of fuel are used. We have been told by witnesses that in some of the first-class English malt-making oven coke is used. The fumes of oven coke are very different from the fumes of anthracite?—You can get such from pure coke, and also from anthracite. In our high-dried malts we cannot get the same heat from coke to apply to the malt as from anthracite. Especially for stout brewing, we find we get heat from anthracite that gives our malt a flavour, which you might call an oatmeal flavour, which you cannot get otherwise.

7698-99. Have you ever used peat for fuel in your kilns?—Once, and once only, and we had to take the whole kiln down before we could make brewers' malt on it again. We could not get quit of the flavour.

7700. But for distillers' malt it would be suitable?—Yes. It was for a distiller we made it. His works were burnt down, and we did it for him, and the whole kiln was impregnated with peat to such an extent that we could not use it.

7701. The peat fuel is practically used largely for malt for whisky?—Entirely to give whisky the flavour.

7702. Is there any other fuel used for malt for whisky?—Yes, coke.

7703. The greater part of the whisky is made from malt dried by other fuels than peat?—I should say so, the greater part.

7704. Have you made any change in your practice in consequence of the discovery of the liability of malt to arsenic?—No.

7705. Have you had chemical tests made of your malt?—Yes, we have had them regularly made by several chemists.

7706. With what result?—They were found free, except in one case, and that gave us 1-350th of a grain per lb. of malt; the same malt at the same time was tested by three other chemists, who found it perfectly free.

7707. Have you ever had the dust that comes away in the brushing and screening examined?—No, we have not, but our combings that come from the malts were found perfectly free.

7708-9. Do the combings carry with them an outside surface that has been exposed to the fumes of the fire?—Yes.

7710. The combings are chiefly the rootlets?—Yes.

7711. Not the husk?—No husk.

7712-13. Besides the process of screening that takes away the combings, you use brushing to remove incrustation from the outside of the husks?—Yes, we have had brushes in force for about twelve years now.

7714. Have you had any chemical analyses made of the fuel that you used?—We have, and a sample of an anthracite has been declared free from arsenic.

7715. Did you have it done before this scare?—Not before.

7716. Therefore, you have made a little change in your practice in that respect?—We made a change to see if it was pure.

7717. Have you had the malt examined before brushing?—We have not. We have had it always done after it left our screens.

7718. Except in the one case, in which a very small quantity of arsenic was found, no arsenic has been detected at all in the malts?—No, in none of our malts. I may add that we have them done every week by our own chemist, and by other chemists for arsenic. That is since the scare commenced.

7719. What tests for arsenic have been applied?—I believe the whole of them used the Marsh tests.

7720. Have you been asked to guarantee your malt free from arsenic?—We have, and have done so. *Guarantees his malt free from arsenic.*

7721. For some time?—For certainly the last five months. I know our malts have been going to brewers' chemists and found all right. I do not know who the chemists were, but they were found perfectly free from arsenic.

7722. The answers to the questions which have been put to you apply to all your maltings?—My answers apply to all the malts we make ourselves. Of course, distillers' malt is not brushed or screened; it goes with the rootlets attached to it. A distiller uses the rootlets along with the malt, except in certain cases, where malts are used for making yeast, and then they have the very best that can be got. *Distillers' malt usually not screened or brushed.*

7723. The rootlets contain a fermentable matter?—There is a certain amount of saccharine matter in them, and it can be converted to alcohol, I suppose.

7724. If the rootlets were taken off, would the malt lose some of its value for distillers?—I cannot say.

7725. But in beer the rootlets are never used?—Never.

7726. You send away the rootlets to be used for cattle feeding?—Yes; in fact, all our combings go to the Continent for feeding cattle there. We have had contracts for years for all to go to one port. *Malt culms exported as cattle food.*

7727. What place?—They go to Denmark and Hamburg.

7728. You actually send from Scotland food for cattle to Denmark?—Yes, they buy it from us regularly.

7729. Where is your barley grown?—Nearly all in Scotland, and some in Yorkshire.

7730. You use some foreign barley?—Both foreign and home.

7731. Is the greater part of the barley you use home grown?—The larger proportion.

7732. Does the home supply sometimes fail, and necessitate your taking foreign barley?—We require to make a large quantity of malt from foreign grain for brewers' requirements.

7733. Does the foreign malt fulfil certain requirements that cannot be fulfilled by home-grown malt?—It does. The brewers hold that it brightens the beer more quickly. *Foreign barley largely malted for brewers,*

7734. May we take the answers you have given as applying on the whole generally to other large maltsters in Scotland?—I think so.

7735. The same system as you follow is practised by the others?—I think so. Everyone has his own system, but I think they are all very particular.

7736. (*Sir William Church.*) Do the distillers use very much foreign barley?—Some of our distillers use nothing but foreign barley, and others use a large proportion of home. The Highland distillers and the distilleries in the north use nearly all home barley, and they fall back on heavy foreign when they cannot get home; that was owing to the great demand for whisky a few years ago, and the great quantity of whisky distilled. *and for distillers,*

7737. You mean by the northern whiskey makers the people about Inverness, for instance?—And on the West coast, too.

7738. They use chiefly home-grown barley?—Yes.

7739. That barley must be less well harvested than the barleys of the Southern counties?—Certainly it is; but in some cases some of our northern districts in Scotland grow as fine barley as I ever saw anywhere—Cromarty, Ross-shire, and Inverness.

7740. But they are more liable to have it injured in the harvest?—It depends entirely on the weather. We have seen barley grown in the finest counties in England ruined by getting rain before we got it. Our barleys were not so ripe, and could stand up against the weather, whereas English barleys being riper would give way.

7741. You told us that the distillers, who want, of course, a very high percentage of alcohol, use home

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malt to a very great extent. We have been told that you want the foreign malt because weight for weight it contains more fermentable matter than the home malt, and less nitrogenous matter?—The northern distillers and the west coast distillers make malt whisky. The southern distillers are raw-grain distillers, and they not only use a large quantity of Indian corn converted, and they malt this light foreign barley to assist them with their converted maize. There are two distinct distillers, the grain distiller and the malt distiller.

especially raw grain distillers.

7742. I do not know whether you could answer this question for me. I suppose that the presence of nitrogenous matter in the malt in undue proportions is not so important for the distiller, who distils his product, as for the brewer who does not?—That I could not say.

7743. (*Dr. Whitelegge.*) In one sample, and one only, arsenic was found in a very small proportion—1-350th you say?—Yes.

7744. Was that brushed?—Yes. It was ordinary screened malt that went from one of our malthouses. It was screened and brushed.

7745. Do you make more than one class of malt?—We do.

7746. Several classes?—Yes.

7747. Is brushing applied equally to all?—All our pale malts are brushed and screened, and have been so for fully twelve years.

7748. How long has it been the practice to pick over the fuel in the way you describe to us?—Our man has told us it has gone on ever since we got it from him.

7749. Do you stipulate for that?—Yes; we made a stipulation for nothing but pure anthracite coal, and it has to be picked over.

7750. (*Chairman.*) Can you give the Commission the form of guarantee that you use?—As far as my memory goes we guarantee our malts pure.

Form of guarantee of malt given.

7751. (*Mr. Cosmo Bonsor.*) Perhaps you will send it in?—I will send a copy with pleasure; it is a stamped form. "Our malts are free from all foreign or poisonous matter." We stamp our invoices with this when requested for a guarantee.

7752. (*Chairman.*) That is your guarantee?—Yes.

No guarantee with fuel.

7753. And the condition that you exact in respect to the coal, to have it hand-picked by the people at the pit mouth; have you that form?—We have not that in writing; we simply insist on nothing but pure anthracite coal being given to us. I should just like to say, of course, that we use coal in our kilns, but we use to a large extent coke in our retorts. We are large makers of black malt. Of course these are hermetically tight.

7754. The black malt is not exposed to the fumes at all?—No.

Black malt not specially exposed to fumes.

7755. The black malt is made from grain first malted in your kilns?—It is first dried at our kilns, and then converted into black malt in the cylinders or the retorts.

7755. But so far as the kilning is concerned there is no distinction?—No.

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7757. And then you put it afterwards into the cylinder, like a coffee roaster?—Yes.

7758. In these cylinders you use whatever fuel you like?—What we can get the greatest heat from. We have not the same draught, and therefore we cannot use anthracite coal with it.

Kiln-drying of barley.

7759. (*Mr. Cosmo Bonsor.*) Do you kiln-dry your barley?—All our home barleys.

7760. That is kiln-dried with anthracite, and not coke?—With anthracite, and not coke.

7761. (*Chairman.*) In that first drying, the heat is much less than in a final kiln drying?—A great deal less.

7762-65. (*Dr. Whitelegge.*) Do you know anything of any method or suggestion of treating fuel with lime, or other base in such a way as to prevent it giving off arsenic?—I never heard of it.

Flavour of fumes thought t be essenti

7766. (*Chairman.*) I wish we could really get information of a positive kind, whether or not the exposure of the grain to the actual fumes of the fire is required to get the proper flavour. We have asked many gentlemen who know their own business well, and know the business generally, and we have got no decided answer, but merely the answer that there is a general opinion or idea that the hot air which kiln-dries the malt ought to come from the fire, if the beer is to have the desired flavour, but we have no experimental proof of that opinion at all. We had one interesting statement to the effect that in a certain particular case of kiln drying, the malt was not exposed to the fumes of the fire, and it was very good. Have you information of that kind?—There has been only one kiln recently erected in Scotland to dry malt without a direct fire, and that has been erected to make lager beer, because when they put it on the other kilns they found they wanted not to dry it so highly. I do not know the result of that.

7767. But that makes lager beer?—Yes; I question whether the malt would make Scotch beer. But I have not heard the results.

7768. There does not seem any good reason to expect that if the malt was dried with hot air at the same temperature, and to the same amount of dryness, without the fumes having come from the fire itself, the result would not be as good?—I do not think it would be as good.

7769. (*Mr. Cosmo Bonsor.*) Could you sell it?—I question whether I could.

7770. (*Chairman.*) You have never made the experiment?—I have been asked by a distiller to make malts for him when he got into trouble.

7771. (*Professor Thorpe.*) Is not the distinction rather of the same order as that which obtains between meat roasted at the fire and meat roasted in the oven; there is a belief on the part of some people that meat roasted in the oven has not the same flavour as when roasted before the open fire?—So I understood.

Mr. Egbert Grant Hooper, called; and Examined.

Mr. E. G. Hooper.

7772-5. (*Chairman.*) You are a Fellow of the Institute of Chemistry, Fellow of the Chemical Society, and a Member of Council of the Society of Chemical Industry?—Yes.

7776. You have been an analyst for 24 years in the Government Laboratory?—That is so.

Samples of arsenical beer, on which rebate claimed, tested at Government Laboratory.

7777. What have you to say with regard to experience of the Government Laboratory in the question of the presence of arsenic in beer?—The question of the presence of arsenic in beer and brewing materials first presented itself officially at the Government Laboratory at the beginning of December last, when, in consequence of the discovery of arsenic in certain beers brewed in Lancashire, applications were made to the Board of Inland Revenue to permit the destruction of the contaminated liquor in the presence of Excise officials, with a view to the repayment of the duty which had been charged upon it. Samples of such beers were then forwarded to the Government Laboratory, and continued to be received for some time. In all 748 samples have been lodged, representing 28,264 barrels, the produce of 67 brewers scattered throughout 11 counties, but mainly in Lancashire, Staffordshire, and Yorkshire. It cannot, however, be asserted that this comprises the produce of every brewer who may have used arsenicated materials, as some are known to have destroyed their beer immediately they became aware that it was contaminated, and without lodging applications for the repayment of duty. An examination of the brewers' entries of the materials used in the particular brewings, together with a determination of the exact original gravity, and a qualitative examination of the beer for arsenic, would have sufficed to substantiate the claim for drawback, but with a view of affording information to the Royal Commission, it was decided to make a more detailed examination in order to obtain some precise knowledge as to the extent to which the beer had been contaminated. The accurate estimation of the amount of arsenic in so large a number of samples would, of course, have occupied a very considerable amount of time, and it seemed unnecessary to do more than to make a selection from the produce of each brewer. In all 143 quantitative determinations of the arsenic in these beers have been made, and full particulars with reference to the origin of the samples, the dates of brewing, and the proportions of arsenic found are given in Table I., from which it may be

Mr. E. Hoop

Quantit determi tions m

seen that the results are fairly representative of the whole. There is no reason to suppose that any further information as to the order of amount in which arsenic was present in the contaminated beers would have been obtained if the entire number had been quantitatively examined. It may be stated that in the Government Laboratory the estimation of minimal amounts of arsenic in metals, such as zinc, copper, and tin supplied by contractors to the Post Office, India Office, etc., is of constant occurrence, and considerable attention has been given for some years past to the subject of its accurate quantitative determination. It appeared possible that the process employed in such cases might be so adapted as to permit of the separation of small quantities of arsenic from beer and brewing materials—that is, from solutions containing a relatively large amount of organic matter, and experiments were made, to begin with, to ascertain how far the associated organic matter interfered with the accurate estimation of arsenic by the well-tried methods hitherto used. Known quantities of arsenious acid were added to wort and beer, and after concentration, the arsenic was precipitated with sulphuretted hydrogen. The sulphide of arsenic, with a varying amount of organic matter which falls out of solution in the course of the treatment, was then filtered off, and afterwards distilled with ferric chloride and hydrochloric acid. Under these circumstances the arsenic distils as arsenious chloride, accompanied only by a small amount of organic matter, from which it can be readily freed, and the arsenic is finally precipitated and weighed as arsenious sulphide.

7778. You say "a small amount of organic matter from which it can be readily freed." Will you describe to the Commission how it is freed from organic matter?—The precipitate of sulphide and of organic matter is collected on a filter paper, the filter paper is rolled up with its contents, and transferred to a small flask, where an addition of hydrochloric acid and ferric chloride is made, and, on heating, the arsenious chloride distils off, carrying over at first a trace of organic products, but only a trace. The distillate contains the whole of the arsenic. It may be necessary to redistil it to free it from the traces of organic matter carried over, but after such distillation the sulphide is precipitated with sulphuretted hydrogen, and is weighed on a Gooch cansule on a layer of asbestos. The apparatus is in the next room if the Commissioners would like to see it.

7779. You said that the distillate carries away the whole of the arsenic. Have you tested the residue to see whether or not there is some arsenic in it?—Yes; after the first distillation a second distillation is taken, and the distillate collected apart. Sulphuretted hydrogen is passed through that second distillate to see there is no arsenic. Should there be arsenic a third distillation is taken, and so on, until a distillate is obtained which contains no arsenic.

7780. But, as a rule, is all the arsenic carried off in the first distillation?—Where the quantity is small, as in any of these beers, it is so. Where the quantity is large, as in some of the experiments we have made, amounting up to 19 or 20 milligrammes instead of 2 or 3, then a third or fourth, and in some cases where the organic matter has been considerable, as where we have taken a large volume of wort to operate upon, the five or even six distillations were necessary to get over the last trace of arsenic. (*The apparatus was exhibited, and explained to the Commission.*) The beer having been concentrated from a litre down to about 150 cc., is acidified by the addition of hydrochloric acid; sulphuretted hydrogen gas is passed through it, and we then get the arsenic precipitated with a certain amount of organic matter. After standing for some hours it is filtered, generally the next morning, on a plate filter just covered with a filter paper, and the amount of matter which separates is of *this* character. This includes the arsenic and the organic matter. It is rolled up with its contents and transferred to this small flask, where hydrochloric acid and the ferric chloride solution are added, and the distillation is then commenced.

7781. The paper disappears?—It becomes more or less charred and disintegrated. The connections are all ground so as to fit tightly and no cork or rubber is in any way in contact with the hydrochloric acid which distils over, carrying with it the arsenic chloride. It meets nothing but glass on its way; the whole of the arsenic chloride is retained in the first receiver, but by way of precaution, lest any trace should escape condensation, a side delivery tube passes any vapour through a U tube containing a small quantity of water. This distillate contains the whole of the arsenic. Sulphuretted hydrogen is then passed through the solution, with the result that the arsenic is precipitated there, not quite of pure colour. This is separated and redistilled, with the result that a pure distillate of arsenious chloride is obtained, which is once more precipitated by sulphuretted hydrogen, and the pure arsenious sulphide is then filtered on to a small perforated Gooch capsule coated with a little asbestos.

7782. How is this asbestos prepared?—It is treated with hydrochloric acid washed and heated to redness.

7783. This looks like a piece of fabric?—Yes, the finely divided asbestos fibres settle in a felt-like layer.

7784. It simply results from the asbestos being allowed to settle?—Yes.

7784*. (*Professor Thorpe.*) It has not merely settled but been pulled into a tight mass by the force of the pump?—Yes.

7785. (*Chairman.*) How is the asbestos got into that finely subdivided condition originally?—A special preparation of asbestos is sold for the purpose, but we go through it carefully, and see it is finely divided; it is shaken up with water, and a little of the water is poured on, leaving the layer of asbestos.

7786. This makes a very thorough filter?—Yes.

7787. And allows nothing of the precipitate to go through?—None whatever.

7788. Is it as thorough a filter as the best blotting-paper filter?—Yes; it is better in many respects than even the finest papers we have.

7789. As thorough in its prevention of anything going through?—That is so. It has also the advantage afterwards that, unlike paper, after being dried it is not hygroscopic; it does not take up moisture, so that you can weigh it without any danger of its increasing in weight from the absorption of water from the atmosphere.

7790. Gooch's filter, including the small Gooch capsule, and the use of the asbestos you have described, is a well-known process?—Yes.

The method tested with malt worts made in the laboratory.

7791. What have you to say about the validity of this method?—The validity of this method of determining the amount of arsenic in beer and brewing materials was established by the following experiments, viz.:—(1) Malt worts produced in the laboratory were examined by the process, and proved to yield no arsenic. (2) To malt wort proved to be free from arsenic, known quantities of arsenious oxide were added, and the arsenic then separated and determined. Thus: Arsenious oxide added 0·5 milligrammes, quantity found 0·56 milligrammes; arsenious oxide added 1·9 milligrammes, quantity found 2·1 milligrammes; arsenious oxide added 4·8 milligrammes, quantity found 4·9 milligrammes; arsenious oxide added 19·2 milligrammes, quantity found 18·8 milligrammes.

7792. Added to how much wort?—To either a litre, or half a litre of malt wort. To prove that beer might be concentrated directly, i.e., in the slightly acid condition, without loss of arsenic, the following experiment was made. Arsenicated beer from a brewery was divided into two portions of 900 c.cs. each. One portion was directly evaporated, and the other was first rendered just alkaline by the addition of pure caustic soda, and then evaporated. The two experiments were otherwise conducted alike, and the arsenic estimated by the process already described. The results in the two cases were 0·21 and 0·20 grain of arsenious oxide per gallon of beer. As regards minimal quantities, it may be pointed out that quantities of arsenious sulphide not exceeding two-tenths of a milligramme are readily isolated and weighed. Two-tenths of a milligram of arsenious sulphide calculated on a litre of beer equals 0·011 grain per gallon, or one part in more than six millions, and the same weight calculated on 100 grammes of sugar or of malt equals 0·011 grain per lb., whilst one litre of beer or 100 grammes of brewing sugar or of malt does not represent the maximum quantity that it is possible to employ for analysis when using this method. Further experiments are described later in connection with the study of the influence of fermentation. For the determination of arsenic in brewing sugars a weight of 50 or 100 grammes of the sugar is dissolved in 150 c.cs. of water, acidified with hydrochloric acid and the arsenic precipitated with sulphuretted hydrogen, and ultimately separated and weighed in exactly the same manner as in the case of beer. In the case of malt the same process is used, the arsenic

Similar method of testing malt.

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being removed from the malt, where unground, by heating two or three times with hot water, containing a little pure alkali, and where ground, by first mashing and then thoroughly washing the grains. The washings, or the combined wort and washings, as the case may be, are then concentrated, and treated for the separation of the arsenic by the process adopted for beer.

7793. (*Chairman.*) Would the alkali suffice to take the arsenic out of any grain when not ground?—There would be no difficulty whatever in taking the arsenic out.

7793a. Would it not take a long soaking before the arsenic would come out?—No. Boiling water dissolves 11 per cent. of arsenious acid, consequently the very small quantity of arsenious acid present on the malt would be readily dissolved.

7794. If on the outside of the malt?—It always is if it is unground.

7795. But if there was any arsenic inside it would not come out so readily?—No, it would be necessary to practically turn the malt into wort.

Question of combination of arsenic with organic matter of beer.

7796. What have you to say as to the influence of fermentative action on arsenious or arsenic oxide present in wort, with special reference to the possibility of the formation of so-called organo-arsenic derivatives and consequent failure to detect the arsenic in such compounds?—It was considered advisable that a fermentation experiment should be made on a scale sufficiently large to afford clear evidence of any formation of organo-arsenic compounds from which arsenic would fail to be separated by the process described. With a view of imitating, as far as laboratory appliances would permit, the conditions obtaining in practice, it was decided to operate upon a relatively large volume of wort containing from two to three grains of arsenious oxide per gallon. In such a case the quantities of liquid and of arsenic might be anticipated to afford an unequivocal result, and if any loss occurred in consequence of the increased difficulty of separating the last trace of arsenic from the considerable amount of organic matter accompanying the sulphide, as first precipitated and necessarily distilled with it, this would tend, not to obscure, but to increase the weight of evidence of the formation of such organo-arsenic compounds. A quantity of wort of 1060° gravity was accordingly prepared and divided into three parts. To one part (a litre) yeast was added in equal quantity to that used in the two succeeding experiments, portions of the same bulk of yeast being used in each of these cases. When fermentation was complete the liquid was concentrated without separating the yeast and the whole tested for arsenic. No arsenious sulphide was obtained, and the freedom from arsenic of both wort and yeast was thus established. To five litres of the wort 193·7 milligrammes of arsenious oxide was added and then yeast as before. Fermentation was allowed to proceed until the specific gravity of the resulting beer had been reduced to 1016°, and the whole bulk, including the yeast, was then concentrated and the arsenic determined as in previous instances. The amount of matter first separated was, of course, large, and several distillations were necessary before a distillate was obtained which contained no arsenic. Finally the pure arsenious sulphide, as weighed, equalled 190·3 milligrammes of arsenious oxide against 193·7 milligrammes added. Thus 98·2 per cent. of the arsenic present was recovered under these conditions, or, in other words, instead of 2·71 grains per gallon known to be present, 2·65 grains were actually found, and if any organo-compound of arsenic was formed, the extent to which it eluded detection amounted to no more than 0·06 grain of arsenious oxide per gallon. As a measure of the action exerted by yeast in removing arsenic from arsenicated wort the following experiment was next made. To a third portion of the wort previously tested, arsenious oxide was added to the extent of 2·51 grains per gallon. It was then fermented by the addition of the yeast already proved to be free from arsenic, and when fermentation was complete and the bulk of the yeast had deposited, the wort was syphoned off and cleared by the addition of finings. When the finings had settled, five litres of the clear beer were separated, and in this quantity the arsenic was determined as before. The arsenic found amounted to 171·9 milligrammes, against 179·8 milligrammes of arsenious oxide known to be present, correction being made for the alteration in volume due to the addition of finings. There was thus a recovery of 95·6 per cent., and diminution of arsenical contamination by the removal of the yeast formed during fermentation in this particular case therefore did not exceed exceed 4·4 per cent. even in a strongly contaminated beer. Expressed in grains of arsenious oxide per gallon the reduction was from 2·51 to 2·40 as an extreme result, for this determination again was made on the large quantity of five litres. It remains to be determined how far hops (with or without associated sulphur) may influence the removal of arsenic by the formation of arsenious sulphide, which may be removed either by straining through the hops in the hop-back, or by subsequent deposition on the surface of the yeast. To prove that arsenic oxide if present would be isolated by this process as readily as arsenious oxide, and that fermentation in this case also in no way interfered with the ultimate determination of the whole of the arsenic present, two further experiments were made. Known weights of arsenic oxide were fully oxidised by boiling with bromine-water, and after the excess of bromine had been boiled off, the solutions were added to wort, and the latter fermented. When fermentation had ceased, the resulting beers were concentrated, and the arsenic present in each case was determined as in the previous experiments. The results were as follows, viz.:—

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EXPERIMENT I.

	Milligrammes.	milligrammes.
Arsenic equal to arsenious oxide	added 3·45	found 3·45

EXPERIMENT II.

Arsenic equal to arsenious oxide	„ 0·7	„ 0·8

No alteration in recoverable arsenic results from fermentation

A control experiment was carried out in this case also, and the wort and yeast used proved to be free from arsenic. It will be seen that these fermentation experiments afford little or no evidence of the formation of organo-arsenical compounds, but, on the contrary, indicate that there is either no production of compounds from which arsenic cannot be separated by the ordinary tests, or that, at the outside, such compounds are only formed to an extent that for practical purposes is quite negligible.

whether arsenious acid or arsenic acid is added.

7796a. (*Chairman.*) I see you say "known weights of arsenious oxide were fully oxidised by boiling with bromine water"?—Arsenious acid on being heated with an oxidising agent, such as bromine, becomes converted into arsenic acid. Arsenic acid is not immediately precipitated by sulphuretted hydrogen. In other words, it has to be reduced to the arsenious condition before sulphuretted hydrogen acts upon it with the production of arsenious sulphide. Therefore it might be contended that if arsenic acid were present in any of these brewing sugars and went through the brewing process unchanged, the process of precipitating that arsenic by means of sulphuretted hydrogen would fail so far as arsenic acid was present. We have proved, whether arsenic acid or arsenious acid be present, both are separated and determined by this process.

7797. (*Chairman.*) What was the composition of the wort used for fermentation in the experiment?—It was entirely malt wort.

7798. No glucose?—No glucose was added.

7799. Before it was fermented was it boiled as would be done in actual brewing with hops?—Yes, it was boiled, but no hops were used that the question might not be complicated by any action the hops might have on this particular experiment.

7800. In the experiment in which the yeast was separated, was the arsenic in the yeast estimated?—It was not.

7801. Have you any evidence as to the form in which the arsenic is present in the yeast?—None.

7802. In these experiments have bi-sulphites or other preservatives been added?—No preservatives were added.

7803. Nor phosphates?—No.

7804. Nor yeast foods?—No.

(*Professor Thorpe.*) Have you any reason to believe that any of these things would modify the results?—No.

7805. Assuming that the wort has been made partially with a saccharine solution such as glucose or invert, is there any reason to believe that the results would be in any way modified?—I think not.

7806. (*Sir William Church.*) When you added compounds of arsenic such as cacodylic acid or any of its salts, you would not recover them by this method?—

Express experiments have not been made with cacodylic compounds, but it has been proved here that no cacodylic compound is formed naturally in malt wort, or if any such compound is formed, it is actually operated on by the sulphuretted hydrogen and is obtained in this process. There is no evidence, however, of the formation of any such compounds in an ordinary fermentation.

7807. That I follow and understand, but supposing that it were present, this process would not discover it, would it?—It is stated that cacodylic acid is not precipitated by sulphuretted hydrogen. If sulphur compounds are formed they appear to be either soluble in or decomposed by hydrochloric acid.

7808. But you have not performed any direct experiments for that purpose?—No.

7809. You have kindly shown the Commission all the steps of this process, which is very complete, but at the same time it does not seem to me to be a very laborious chemical process? It is simple enough?—That is so.

7810. I was going to ask whether in your opinion such a test as that could be satisfactorily worked by any competent analytical chemist?—Quite so. There is no difficulty at all about it. Every piece of chemical work demands care and accuracy. There is nothing involved about this; it requires just the usual care and accuracy which any good piece of chemical work demands.

7810a. (*Chairman.*) It is very much more laborious or longer than the Marsh test?—Yes. Naturally it takes a considerably longer time. This is a quantitative determination instead of a mere qualitative test.

7811. This determination would require at least two days?—No. If you are doing a number two would be finished every day. Two would be started to-day and completed to-morrow, when two further experiments would be started so that the output would be two a day.

7811. One experiment could not be completed in less than two days?—Not on the lines we have taken.

7813. The Marsh test is much more speedy?—Yes, but it is not a gravimetric test.

7814. The Marsh test still continues to be very valuable for many purposes, but in your view is not a quantitative test?—Most valuable. Of course it is used as a quantitative test as well.

(*Sir William Church.*) You can get evidence of the presence of arsenic by this test when you do not get sufficient precipitate to be weighable?—Yes. If you will take the smaller of the Gooch's, you will see there is a slight yellow stain on one. We have had several illustrations where that has weighed less than 1-10th of a milligramme. We have had evidence of a smaller quantity than one could actually weigh. But I think we would generally stop at a point where we could weigh.

7815. (*Chairman.*) In that case what was the result obtained from?—A litre.

7816. Could the Reinsch test have given any indication whatever of arsenic in that case, the exceedingly small quantity?—I should be very doubtful about it myself, but my experience of the Reinsch test is not so considerable as that of many others.

7817. Would the Marsh test have shown anything in this small case?—It would.

7818. So that the Marsh test would show something, when the Reinsch test shows nothing?—I think so.

7819. The quantity used in the Marsh test need be very small to show it?—The common quantity used is 10 cc., but I have not found it advisable to limit it to that small quantity myself. I prefer to use up to 50 c.c.

7820. Even that is only 1-20th part of the amount used in the quantitative test you have described?—That is so.

7821. Could either the Marsh or the Reinsch test be rendered sensitive for the exceedingly small quantity you speak of by applying them to a much larger quantity of liquor than 50 cc.?—Yes, I think they could.

7822. Even without concentrating the liquor?—No; I should proceed in that direction, I think.

7822a. (*Professor Thorpe.*) There is a practical difficulty in the employment of any concentrated solution by the Marsh test?—Yes, due to the frothing.

7823. When you take these highly sweetened and concentrated solutions they froth in the apparatus to an inconvenient extent, and therefore the whole froth is carried bodily forward in the gas and soils the tube?—Yes, there are limitations in the Marsh test.

7824. (*Chairman.*) You need to get quit of the thick gummy matters?—Certainly.

7825. Does that apply also to the Reinsch test?—Yes; as concentration proceeds in the Reinsch it is very liable to bump considerably; we have had the liquid thrown right up to the ceiling in the laboratory you were in this morning.

Claims that sulphuretted hydrogen precipitates all the arsenic from beer.

7826. (*Dr. Whitelegge.*) Nothing is done with the filtrate after the first precipitation with sulphuretted hydrogen, is it?—We always keep it over, and it has repeatedly been further examined. The gas has been again passed through it, and if any precipitate whatever falls—because organic matter will fall on standing—it has been again filtered and the precipitate distilled. But we have not found any arsenic so retained, proving that the whole is taken out at the first precipitate. But that has always stood in our quantitative experiments all night.

7827. Have you seen the evidence that Dr. Campbell Brown gave us the other day?—I saw the newspaper report.

7828. He told us that taking, not an experimental beer, but what we may call a Bostock beer in acid solution, sulphuretted hydrogen gave a precipitate?—Yes.

7829. Passing sulphuretted hydrogen through the filtrate he sometimes got a second precipitate, but passing a second, third, and fourth time gave no further precipitate. Nevertheless, on oxidising the organic matter present in the filtrate he obtained a residuum of arsenic?—I think there are some practical difficulties to meet which experience with the process is necessary. Probably Dr. Campbell Brown did not get so far. I consider it very essential that a clear filtrate should be obtained. Dr. Campbell Brown, I gather, did not succeed in getting that clear filtrate. A clear filtrate cannot be obtained readily if the solution is filtered cold, even with the use of the best paper. But if heated nearly to the boiling point, and then filtered, an absolutely bright filtrate is readily obtained. Under those circumstances there can be no danger of any arsenious sulphide failing to be obtained on the paper. I have alluded to it as being absolutely essential that a clear filtrate should be obtained.

7830. (*Chairman.*) Have you tested the clear filtrate for arsenic?—Yes, on several occasions, and we have never found any carried through.

7831. The first filter is an ordinary paper filter?—Yes.

7832. And you found no arsenic has come through that?—That is so.

7833. (*Dr. Whitelegge.*) Have you tested the filtrate by Marsh and otherwise than by sulphuretted hydrogen?—No, I have not done that.

7834. You have not adopted the particular procedure of oxidising the organic matter?—No, that would be too lengthy. The essence and advantage of this process is that it avoids the necessity for that.

7835. The suggestion I understand him to make is not so much that there is arsenious sulphide there that has not been collected but that the arsenic has not gone down?—Quite so. But our experimental evidence proves that there is no such compound as that. Arsenic is put into wort, and the latter fermented. The arsenic is then separated and found to be equal in amount to that added, thereby showing there has been no such combination of arsenious acid with organic matter as precludes the precipitation of arsenic under those circumstances.

7836. Do you think it is safe to assume any arsenic present will come down as a sulphide?—The experimental evidence establishes that.

7837. But is that entirely in accord with what Dr. Campbell Brown found, dealing with a beer made from arsenicated materials?—143 determinations have been made on Bostock's beers, and the quantities obtained show that there could be no loss because the quantities are larger than a number of other people have found.

7838. In some cases, but in other cases your method has given a smaller quantity, has not it?—You mean in a reference case?

7838a. Yes?—But the results obtained in the Govern-

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ment laboratory were supported and confirmed by other evidence. I could give you the particulars if you wish them.

7839. (*Sir William Church.*) Your result is the result of actual weighing?—That is so.

7839a. The others were only the results of estimation?—In some cases, Dr. Campbell Brown does weigh his, but he goes through the process of destroying the whole of the organic matter.

7840. (*Chairman.*) Dr. Campbell Brown gave very distinct evidence to the effect that he found in the first place a precipitate by sulphuretted hydrogen; in the second place a little more precipitate. A third, fourth, and fifth gave no more arsenic. Then he oxidised, by chlorates I think, and got a residue from which he obtained rather more arsenic than he had got out in the first, second, and third put together; that is substantially his evidence, and he gave it in the most circumstantial manner. Can you suggest any explanation of that?—There are several points upon which the accuracy of his results would depend. First of all the solution must be completely saturated with sulphuretted hydrogen or the whole of the arsenic would not be precipitated, and on each fresh treatment he would get down a further precipitate with sulphuretted hydrogen. But I am inclined to think from my own experience that the explanation of his results—that is, those results of getting successive quantities, is due to an inefficient filtration. There is the extreme difficulty in obtaining a clear filtrate from a beer of this kind unless it is specially treated. I found it so myself, but it is quite possible that with efficient filtration you can get out the whole of the arsenic present. Sulphur must, of course, be first formed. If you pass sulphuretted hydrogen for only a limited time you may precipitate half the arsenic, but if you pass it long enough the whole of the arsenic is thrown down. I should not imagine Dr. Campbell Brown would pass sulphuretted hydrogen gas through his solution for a limited time, and therefore that is probably not the explanation.

7840a. (*Dr. Whitelegge.*) He says: "One litre of the beer is concentrated, is acidulated, and precipitated by sulphuretted hydrogen, the gas being passed until the laboratory is closed for the day," and that is repeated twice or three times and four times?—That is without any previous oxidation.

7841. This was an experiment to show that oxidation is necessary. After having removed as much as can be removed by the treatment with sulphuretted hydrogen and separation of the deposit, there remained in solution a very material amount, equal to that removed by the sulphuretted hydrogen?—Our experience is exactly the contrary to that.

7841a. That I gather, and I want to know if you can throw any light on it?—I think it is due to the filtration. He said in the notes I saw of his evidence that he failed to obtain a clear filtrate.

Whether arsenic brewed with the beer or not makes no difference to the test.

7842. He told us also that the discrepancy did not arise where arsenious oxide had been added to finished beer; it was only in beer brewed from arsenicated materials that he found this difficulty in getting down a very large proportion of the arsenic?—The only difference is that there had been a fermentation in between. We have made experiments on that basis, and we found no difference under such circumstances.

7843. Your artificial brewing gave results in accordance with the experiment with directly adding arsenic?—Quite so.

7844. Dr. Campbell Brown's experiments did not?—No.

7845. (*Professor Thorpe.*) Is there any *à priori* reason to believe that by brewing the arsenious oxide would change?—None that I am aware of.

7846. (*Dr. Whitelegge.*) In speaking of yeast you say: "There was thus a recovery of 95·6 per cent. and diminution of arsenical contamination by the removal of the yeast formed during fermentation in this particular case did not exceed 4·4 per cent. even in strongly contaminated beer." Would not the quantity of arsenic thus removed, if expressed as a percentage of total arsenic, be likely to be less marked in a strongly contaminated beer?—Not where the arsenic was not present to such an extent as to inhibit the growth of the yeast. Two grains to the gallon would not inhibit the growth of the yeast, so that for all practical purposes there was a normal fermentation.

7847. I was looking at it in the other way. Yeast is able to take up a small amount of arsenic. Would not the amount of arsenic that the yeast could take away be relatively larger if the initial amount of arsenic is small?—No, I should imagine that since it had plenty of food on which to feed it would avail itself to the full and take out the larger quantity.

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Affinity of yeast for arsenic.

7848. (*Professor Thorpe.*) That is on the supposition that arsenic is a yeast food at all?—Exactly.

7849. (*Dr. Whitelegge.*) Supposing we were experimenting with yeast upon two worts, one largely arsenical and the other arsenical to a slight degree, the amount of yeast being the same in each case. If the yeast abstracted the same amount of arsenic from each wort, then the percentage of arsenic taken up by the yeast would be higher in the case of the slightly arsenical wort?—Yes, supposing it is constant throughout it would.

7850. (*Professor Thorpe.*) Is there any evidence to show that yeast takes up a constant amount of arsenic?—No.

7851. (*Dr. Whitelegge.*) You say that it did not exceed 4·4 per cent. even in the strongly contaminated beer. I should have thought the suggestion was the other way round?—I do not think so. I quite think it would take up more rather than less, the more the arsenic is present.

7852. (*Sir William Church.*) The stronger the contaminated beer the more chance there would be of some possible compound of arsenic being entangled in it?—Quite so. All the sediment goes down with the yeast. Not merely all the yeast has gone down, but whatever matter has fallen out of the solution in the process of brewing together with the finings has been carried down, and whatever could possibly be entangled has amounted only to this percentage. I do not contend that yeast has taken up any.

7853. (*Professor Thorpe.*) I should like at this stage to make clear what has been said with reference to the imputation which I gather was made by Dr. Campbell Brown that the Government Laboratory was in the habit of finding less arsenic than several analysts in police cases which had been before magistrates. That is not the case, and I should like to make that clear. Here is a paper which contains the whole of the police cases with which the Government Laboratory has been concerned, and although Mr. Hooper was not concerned in the actual cases——

7854. (*Sir William Church.*) My impression is that we had evidence before us that Dr. Campbell Brown and the Government Laboratory agreed in one case and differed somewhat in another.

Divergent results of different analysts.

7855. (*Professor Thorpe.*) That is not as I read it in the evidence. All my knowledge of what Dr. Campbell Brown said is what Dr. Whitelegge elicited from him. Dr. Whitelegge asked Dr. Campbell Brown whether there was not a certain case in which he found a relatively large quantity of arsenious oxide, in which he was corroborated by Dr. Stevenson, and in which the Government Laboratory found only a small proportion—I think 1-100th of a grain. There was a certain case which was tried at Rochdale in which the Government Laboratory found 1-30th of a grain, and in which they were independently corroborated by two other analysts. That was a beer which was brewed from malt and hops, and was proved by our own Excise officer as well as the brewer himself to be so brewed.

the Rochdale case

7856. (*Chairman.*) Was that a case in which Dr. Campbell Brown found as much as 1-5th of a grain of arsenic?

(*Professor Thorpe.*) That was a case in which he said he found as much as 1-5th of a grain. Then there was another case which was mentioned by Mr. Jones of Wolverhampton. Mr. Jones, of Wolverhampton, who described his process, which, you will remember, consisted in a modification of the Reinsch's method, in which the arsenic was removed from the beer by copper, and afterwards dissolved off the copper and distilled with ferric chloride and hydrochloric acid—in that particular sample of beer Mr. Jones found ·07 grain of arsenious oxide per gallon. We found in precisely the same sample of beer ·19, which is getting on for three times the amount of arsenious oxide which Mr. Jones obtained. On another occasion he found in a certain sample of beer as little as ·09. In that particular case we found as much as ·38, that is to say, four times as much. That I put down to the fact that the copper in Mr. Jones's process does not really abstract the whole of the arsenic from the solution, whereas, of course, by treatment

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with sulphuretted hydrogen our contention is that the whole of it is thrown down, and can be recovered by the mode which has been explained. In a third case, a sample which was received from Doncaster, and was analysed by Mr. Thomson, of Manchester, we were in substantial agreement with him. He found 1-20th of a grain; we found 1-15th of a grain. In all the other cases we have agreed substantially with the analysts. Mr. Lowe, of Chester, who analysed three samples of beer, found only traces, and we returned the amount as about 1-100th of a grain.

7856a. (*Chairman.*) Will you put in this table?

(*Professor Thorpe.*) I think it would be convenient that that table should be put in as being an account of our work with such reference samples as have been received up to this time.

The following is the table referred to:—

REFERENCE SAMPLES of Beer for Arsenic.

No.	Place.	Analyst.	Quantity of Arsenic per gallon certified by Analyst.	Government Laboratory Report.
1	Preston	Mr. Campbell-Brown	"A certain small quantity"	An appreciable trace estimated as not exceeding $\frac{1}{10}$th of a grain.
2	Rochdale	,,	$\frac{1}{30}$th of a grain per gallon	·033 grain As_4O_6 per gallon.
3	Wolverhampton	Mr. Jones	·07 grain As_4O_6 per gallon	·19 grain.
4	,, [Porter]	,,	·05 grain	No evidence.
5	,,	,,	·09 grain	·38 grain.
6	Ruabon		"Contains a certain amount of arsenic."	No evidence.
7	Doncaster	Mr. Thomson (of Manchester).	Found $\frac{1}{15}$th grain	·067 grain = $\frac{1}{15}$th of a grain.
8	Mold	Mr. Lowe	Traces of arsenic	$\frac{1}{100}$th of a grain.
9	,,	,,	,, ,,	No evidence.
10	,,	,,	,, ,,	No evidence.

7857. (*Chairman.*) You can give evidence as to the amount of arsenic contained in beers brewed from arsenicated materials based upon the examination of samples representing 28,264 barrels of beer lodged by 67 brewers on making application for repayment of duty?—Yes.

The following are the tables:—

TABLE I.—EVIDENCE as to the amount of Arsenic in Beers brewed from Arsenicated Materials, based upon the examination of Samples taken on the receipt of applications for Repayment of Duty when the Beer was destroyed.

Quantity of arsenic in beers on which rebate claimed.

Total Number of Breweries - - - - - - - - - - 67
,, ,, Barrels of Beers - - - - - - - - - 28,264

County and Place.	Brewer.	Date of Brewing.	Arsenious Oxide Grains per Gallon.	Vendors of Sugar used in Brewing.	No. of Experiment.	
CHESHIRE:		1900:				
Macclesfield	North Cheshire Brewery	31 Aug.	·42	Bostock & Co.	1	
		19, 27 Sept.	·24	,,	2	
		20 Nov.	·28	,,	3	
Stockport	Robinson, F.	22, 23 Nov.	·05	,,	4	
CUMBERLAND:						
Penrith	Glasson's Brewery	15, 16 Nov.	·09	Bostock & Co. and Boake, Roberts & Co.	5	
		29 ,,	·18	,,	6	
Workington	Workington Brewery	14, 22 Sept.	·13	Bostock & Co. and Freeman, Lloyd & Co.	7	
		12, 17 Oct.	·34	,,	8	
		22, 23 Nov.	·24	,,	9	
		29 ,,	·02	Freeman, Lloyd & Co. only.	10	See Note 1.
		7 Dec.	Trace	,,	11	,,
		13 ,,	,,	,,	12	,,
DENBIGH:						
Wrexham	Lassell & Sharman	18 June	·19	Bostock & Co.	13	
		10 Aug.	·49	,,	14	
		6, 8 Nov.	·46	,,	15	
GLOUCESTER:						
Bristol	Auty & Co.	1, 6 Dec.	·44	Brewers' Invert Co. and Johnson's Saccharum Co.	16	See Note 2.
LANCASHIRE:						
Barrow	Case & Co.	26, 27 Nov.	·12	Garton, Hill & Co., Bostock & Co., and Clowes & Co.	17	

County and Place.	Brewer.	Date of Brewing.	Arsenious Oxide Grains per Gallon.	Vendors of Sugar used in Brewing.	No. of Experiment.	
LANCASHIRE—*cont.*		1900:				
Blackburn	Holden, R.	26, 27 Oct.	·30	Bostock & Co. and Rowell & Schofield.	18	
		13 Nov.	·17	,,	19	
		23 ,,	·57	,,	20	
		27 ,,	·38	,,	21	
	Whewell, T.	16, 17 Oct.	·67	Bostock & Co. and Duttson & Co.	22	
		12, 13 Nov.	·49	Garton, Hill & Co. Duttson & Co.	23	*See* Note 3.
		14, 16 ,,	·29	,,	24	,,
		21 ,,	·40	Duttson & Co. and Bostock & Co.	25	
		22 ,,	·43	,,	26	
		23 ,,	·49	,,	27	
		26 ,,	·53	,,	28	
Bolton	Hamer, J.	14, 21 Nov.	·23	Ince, Pickering & Co.	29	*See* Note 4.
Burnley	Fort, J.	15 Aug.	·58	Bostock & Co.	30	
		6, 8 Nov.	·08	,,	31	
	Grimshaw, J.	14 ,,	·61	,,	32	
	Kenyon, J.	19 ,,	·63	,,	33	
		26 ,,	·67	,,	34	
Burrough	Thorougood's Brewery	13, 20 Nov.	·25	Garton, Hill & Co., Bostock & Co., and Diastatic Extract (name unknown).	35	
Chorley	Hilton, P.	26 Nov.	·16	Bostock & Co.	36	
	Taylor, W.	24 May	·12	,,	37	
		3 July	·20	,,	38	
		27 ,,	·37	,,	39	
Ince	Morton, W.	21, 30 Nov.	·64	,,	40	
Liverpool	Gilmour & Co.	15, 16 ,,	·52	,,	41	
	Glover & Sons	Unknown	·06	,,	42	
	Jones & Co.	15, 31 Oct.	·06	Bostock & Co. and Hallsworth Co.	43	
		7, 8 Nov.				
		1 Feb. 1901	Trace	Trier, Mayer & Co. and Freeman, Lloyd & Co.	44	*See* Note 1.
		1 Mar. ,,				
	Mellor & Sons	24, 27 Nov. 1900.	·34	Bostock & Co. and Liverpool Saccharine Co.	45	
	Robinson's Brewery	21, 23 ,,	·34	Bostock & Co	46	
		26, 28 ,,	·22	Bostock & Co. and Freeman, Lloyd & Co.	47	
	Tarbuck's Brewery	22, 23 ,,	·08	Liverpool Saccharine Co. and Bostock & Co.	48	
Manchester	Bedford Brewery	22 Nov.	·07	American Climax, Bostock & Co. and Johnson's Saccharum Co.	49	
	Boddington's Breweries	23 ,,	·20	Bostock & Co.	50	
	Chester's Brewery Co.	14 ,,	·12	Bostock & Co. and Manbré Saccharine Co.	51	
		21 ,,	·14	,,	52	
	Cornbrook Brewery	1 Oct.	·16	Bostock & Co.	53	
		29 ,,	·24	,,	54	
	Duxbury, Sarah	Unknown	·20	,,	55	
	Groves & Whitnall	23 Oct.	·44	,,	56	
		9 Nov.	·28	,,	57	
		14 ,,	·06	,,	58	
		21, 23 ,,	·35	,,	59	
	Kay's Atlas Brewery	26 ,,	·28	,,	60	
	McKenna's Brewery	Unknown	·20	,,	61	
	Openshaw Brewery	17 Nov.	·37	Bostock & Co. and Valentine, Todd & Co.	62	
		27 ,,	·20	Bostock & Co. and Manbré Saccharine Co.	63	
		22, 23 Nov.	·21	,,	64	
	Seed & Co.	25 Sept.	·32	Bostock & Co.	65	
		9 Nov.				
	Wilson's Brewery Co.	16, 17, 19 Nov.	·03	Garton, Hill & Co., Bostock & Co. and Liverpool Saccharine Co.	66	
	Worsley Brewery	14, 16 ,,	·22	Bostock & Co.	67	
	Yates' Castle Brewery	19 ,,	·03	Manbré Saccharine Co.	68	
		23, 30 Oct.	·24	Bostock & Co. and Manbré Saccharine Co.	69	*See* Note 5
		5, 6 Nov.	·18	,,	70	
		19 ,,	·28	,,	71	
Nelson	Astley's Executors	24 Sept.	·52	Bostock & Co.	72	
		8 Oct.	·90	,,	73	
		20 Nov.	1·73	,,	74	
		27 ,,	3·00	,,	75	
	Strickland, J.	26 ,,	·62	,,	76	
Newton-le-Willows	Forshaw, R.	End of Sept. or early in Oct.	·72	,,	77	
		,,	·87	,,	78	
		1, 21 Dec.	·07	Lichenstein & Co. and American glucose. (Name unkown.)	79	*See* Note 6.

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County and Place.	Brewer.	Date of Brewing.	Arsenious Oxide Grains per Gallon.	Vendors of Sugar used in Brewing.	No. of Experiment.	
LANCASHIRE—*cont.*		1900:				
Oldham	Oldham Brewery Co.	Unknown		Bostock & Co. and Garton Hill & Co.	80	
		,,	·10	"E. D. M. E. Co." McFie & Co., Boake, Roberts & Co. and Lichenstein & Co.	81	
Ormskirk	Ellis, Warde & Webster	9 Nov.	·36	Bostock & Co.	82	
Poulton-le-Fylde	Catterall & Swarbrick	Unknown	·32	Bostock & Co. and Duttson & Co.	83	
Rochdale	Phœnix Brewery	20 Nov.	·29	Ince, Pickering & Co.	84	*See* Note 4.
		23, 26 ,,	·29	,,	85	
		29 ,,	·36	,,	86	
		18 Dec.	·07	,, Duttson & Co.	87	
Waterloo	Thorougood's Brewery	28 Nov.	·03	American Climax Co., and Bostock & Co.	88	
Wigan	Oldfield Brewery Co.	27 Nov.	·04	Liverpool Saccharine Co. and Bostock & Co.	89	
LEICESTER:						
Melton Mowbray	Langton & Sons	2, 9 Oct.	·87	Bostock & Co.	90	
		20, 22 Nov.	·86	,,	91	
NOTTINGHAM:						
Everton	Farmer's Brewery Co.	7 June	·16	Bostock & Co., and Kendall & Son.	92	
		2 Aug.	·21	,,	93	
		14 Sept.	·08	,,	94	
		17 Oct.	·14	,,	95	
		28 Nov.	·76	,,	96	
SHROPSHIRE:						
Market Drayton	Pearce's Crystal Fountain Brewery.	25, 28 Aug	·65	Bostock and Co.	97	
		25, 27 Sept.	·39	,,	98	
		9, 15 Oct.	·15	,,	99	
		9 Nov.	·58	,,	100	
		23, 26 Nov.	·31	,,	101	
STAFFORDSHIRE:						
Ashton-under-Lyne.	Scholfield & Son	27, 28 Nov.	·23	Ince, Pickering & Co.	102	
Bardsley	Shaw & Bentley	21, 23 ,,	·76	,,	103	
Bilston	Harper, R. A.	28 Sept.	·31	Bostock & Co.	104	
		26, 27 Nov.	·33	,,	105	
Burslem	Parker's Burslem Brewery Co.	1, 8 Oct.	·30	Liverpool Saccharine Co., Manbré Saccharine Co., and Bostock & Co.	106	
		1, 8 Nov.				
		20, 26 ,,	·03	,,	107	
Darlaston	J. Pritchard & Sons	26 July	·58	Bostock & Co.	108	
		13 Sept.	1·02	,,	109	
		11 Oct.	1·28	,,	110	
Lichfield	Lichfield Brewery Co.	29 ,,	·37	,,	111	
		26 Nov.	·29	,,	112	
Newcastle	Ridgway & Sons	29 Sept.	·07	Bostock & Co., Garton, Hill & Co., and Valentine, Todd & Co.	113	
		25 Oct.	·11	,,	114	
Stone	Joule & Sons	19 Nov.	·72	Bostock & Co.	115	
Walsall	Lord, J.	26 ,,	·36	,,	116	
West Bromwich	Bates, T. H.	25 Oct.	·25	Bostock & Co., and Kendall & Son.	117	
		16 Nov.	·28	,,	118	
WARWICK:						
Birmingham	Birmingham Breweries Co.	31 Oct.	·63	Bostock & Co., and Clark & Son.	119	
		26 Nov.	·45	Bostock & Co., Brewers' Sugar Co., Greenock & Clark & Son.	120	
	Dare, W.	10 Oct.	1·47	Bostock & Co.	121	
		8 Nov.	1·05	,,	122	
		13 ,,	1·13	,,	123	
		15 ,,	1·01	,,	124	
		22 ,,	·94	,,	125	
		28 ,,	1·40	,,	126	
	Evans, E.	13 Oct.	·69	,,	127	
		22 Nov.	1·21	,,	128	
	Meade & Co.	11 Oct.	·40	,,	129	
		27 Nov.	·66	,,	130	
YORKSHIRE:						
Halifax	Brown and Brear	12 Oct.	·66	,,	131	
		12 Nov.	·15	,,	132	
Ilkley	Ilkley Brewery Co.	27 ,,	·32	,,	133	
Leeds	Albion Brewery Co.	23 Aug.	·22	Bostock & Co., London Glucose Co. (American), and Clark & Son.	134	
		28 Sept.	·21	,,	135	
		17 Oct.	·19	,,	136	
		21 Nov.	·25	,,	137	
		28 ,,	·17	,,	138	
Sheffield	Tomlinson, H., Ltd.	20 Aug.	·58	Bostock & Co.	139	
		29 Nov.	·04	,,	140	
		1901				
Shipley	Seth, Senior, & Sons	14 Jan.	·34	Garton, Hill & Co.	141	*See* Note
		15 ,,	·27	,,	142	
		29 ,,	·05	,,	143	,,

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SUMMARY OF RESULTS.

Proportion of Arsenious Oxide per gallon.	No. of Samples.
3 grains	1
1·0 grain but less than 2·0	9
·9 " " 1·0	2
·8 " " ·9	3
·7 " " ·8	4
·6 " " ·7	11
·5 " " ·6	8
·4 " " ·5	11
·3 " " ·4	20
·2 " " ·3	29
·1 " " ·2	21
·05 " " ·1	14
Less than ·05	10
Total	143

Number of Counties - - - - 11

NOTES.

1. May possibly be due to the malt used.
2. Sugar supplied by Brewers' Invert Co. said to have been manufactured by Bostock & Co.
3. Brewer states that Bostock's sugar was in stock, and may have been used in this brewing by accident.
4. Sugar supplied by Messrs. Ince, Pickering & Co., said to have been manufactured by Bostock & Co.
5. Yeast pressings from arsenicated beer added.
6. Yeast used stated to have been found by Brewer's chemist to contain arsenic.
7. Brewer, prosecuted by local authorities for selling beer containing arsenic, stated that the contamination had been traced by his chemist and was due to the malt used.

TABLE II.

TABLE showing the proportion of Arsenic present in beers brewed in successive months from May to November, 1900.

Month.	Number of Experiment in Table I.	Arsenious Oxide. Grains per Gallon.
May	37	·12
June	13	·19
	92	·16
July	38	·20
	39	·37
	108	·58
August	1	·42
	14	·49
	30	·58
	93	·21
	97	·65
	134	·22
	139	·58
September	2	·24
	7	·13
	72	·52
	94	·08
	98	·39
	104	·31
	109	1·02
	113	·07
	135	·21
October	8	·34
	18	·30
	22	·67
	53	·16
	54	·24
	56	·44
	69	·24
	73	·90
	90	·87
	95	·14
	99	·15
	110	1·28
	111	·37
	114	·11
	117	·25
	119	·63
	121	1·47
	127	·69
	129	·40
	131	·66
	136	·19
November	3	·28
	4	·05
	5	·09
	6	·18
	9	·24
	10	·02
	15	·46
	17	·12
	19	·17
	20	·57
	21	·38
	23	·49
	24	·29
	25	·40
	26	·42
	27	·49
	28	·53
	29	·23
	31	·08
	32	·61
	33	·63
	34	·67
	35	·25
	36	·16
	40	·64
	41	·52
	45	·34
	46	·34
	47	·22
	48	·08
	49	·07
	50	·20
	51	·12
	52	·14
	57	·28
	58	·06
	59	·35
	60	·28
	62	·37
	63	·20
	64	·21
	66	·05
	67	·22
	68	·03
	70	·18
	71	·28
	74	1·73
	75	3·00
	76	·62
	82	·36
	84	·29
	85	·29
	86	·36
	88	·03
	89	·04
	94	·86

Month.	Number of Experiment in Table I.	Arsenious Oxide. Grains per Gallon.
November	100	·58
	101	·31
	102	·23
	103	·76
	105	·33
	107	·03
	112	·20
	115	·72
	116	·36
	118	·28
	120	·45
	122	1·05
	123	1·13
	124	1·01
	125	·94
	126	1·40
	128	1·21
	130	·66
	132	·15
	133	·32
	137	·25
	138	·17
	140	·04

SUMMARY.

Month.	May.	June.	July.	August.	September.	October.	November.
Number of Samples	1	2	3	7	9	21	80
Average As_4O_6	·12	·17	·38	·45	·33	·50	·42

It will be seen from the foregoing tables and the summaries annexed to them that the proportion of arsenic found varied from less than five-hundredths of a grain up to half a grain per gallon in something like three-fourths of the whole number of cases, but that as regards the remaining fourth, the quantity of arsenic ranged from half a grain to about one and three-quarter grains, with one exceptional case of three grains to the gallon. It has been already remarked that a large proportion of these contaminated beers were drawn from the counties of Lancashire, Staffordshire, and Yorkshire, but one sample was brewed at Bristol. In all but 18 instances Bostock's sugar wholly or in part had been used, either in the production of the beer or in priming. In eight out of the eighteen cases where sugar obtained from Messrs. Bostock directly had not been employed it was stated that the sugar, though supplied by another firm, had been manufactured by Bostock; in two instances it was found that the arsenic was due to the use of yeast or of yeast pressings from contaminated beer; in one instance the brewer stated that Bostock's sugar was in stock at the time, and might have been used by accident, and in the remaining seven cases it was alleged that the arsenical contamination had been traced to the malt used. As regards the period over which the arsenical contamination extended, it will be noted that the oldest sample examined was brewed on the 24th May, 1900. Beer at the present time is consumed very shortly after it is produced, and consequently, whilst there are many samples representing the November production—the date at which the contamination was detected—considerably fewer samples of beer produced at earlier dates are available. It may, however, be noted that in the one May sample the proportion of arsenious oxide per gallon was 0·12 grain, the two brewed in June contained 0·16 and 0·19 grain respectively.

7858. All of the same brewery?—No; they are from different breweries. This is regarding them merely in point of time. The three July samples all showed higher proportions of arsenic, and in one case exceeded half a grain to the gallon; in August the average of six samples is 0·45 grain per gallon, and one sample contained 0·65 grain; in September the average is slightly lower (0·33), but one sample contained rather more than one grain of arsenious oxide per gallon; in the October beers, the average is half a grain per gallon, and of the twenty-one samples eight contained more than this—two, from different breweries, containing as much as 1·47 and 1·28 grain per gallon, respectively, though it should perhaps be pointed out that these were in both cases strong beers, the original gravities being 1,076° and 1,066° respectively. As regards the November samples, the average is 0·42 grain of arsenious oxide per gallon, but there are seven samples in which the contamination exceeds one grain, and in one exceptional case the proportion rises to three grains per gallon, the largest proportion shown by any of the samples. This exceptional amount of arsenic was found in a sample of stout (Expt. No. 75) brewed by the executors of William Astley, at Nelson, Burnley, on the 27th November. The result was confirmed by the examination of a duplicate sample, but no sample of the sugar used, which was described as Bostock's 'Caramelised glucose," could be obtained. Another sample of stout produced at the same brewery (No. 74) showed the next highest amount obtained, viz, 1·73 grains per gallon. This was brewed on the 20th November, and half the quantity of sugar used in this brewing was said to be of the same consignment as was employed in the brewing of the 27th November, the other half being of a previous consignment.

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Greatest amount of arsenic found in any of the beers.

7859. Was the same quantity of sugar used in each case, on the 20th and 27th November?—On the 20th November the materials used were 128 bushels of malt and 896 pounds of glucose. On 27th November the materials used were 110 bushels of malt and 672 pounds of glucose. The proportion of sugar to total materials was in the first case 18 and in the second case 16 per cent. No priming was used in the second case, but in the first case it was primed by the addition of Bostock's "porter heading."

7860. (*Sir William Church.*) There was not a very great amount of difference?—No; 16 and 18.

7860a. (*Professor Thorpe.*) The difference is probably in the priming?—That is not included.

7861. In one case the beer was primed; in the other case not?—Yes, that is so.

7861a. (*Chairman.*) The beer on the 27th November contained three grains per gallon, and no priming was used?—That is so.

7862. The beer brewed on the 20th November contained a smaller quantity of arsenic—1·73 grains per gallon?—Yes.

7863. Half the quantity of sugar used in this brewing was said to be of the same consignment as was employed in the brewing of the 27th November?—That is so. The much larger proportion of arsenic in the beer brewed on the 27th November therefore points to the later sugar being more highly contaminated than that delivered earlier. Two beers brewed at the same brewery on 8th October and 24th September, respectively (Nos. 73 and 72) contained arsenic equal to 0·90 and 0·52 grains of arsenious oxide per gallon, and no explanation of the exceptional degree of contamination shown by the two stouts has been found, black beers from other breweries containing less rather than more arsenic than the ales. The strength of the beer in every case has, of course, some bearing upon the quantity of arsenic present, for the original gravity of the samples analysed varied from 1,037° to, in one case, 1,080°, the arsenious oxide in the latter case (No. 128) amounting to 1·21 grain per gallon. In the case of six samples from a Birmingham brewery (Nos. 121 126) the beer of the highest original gravity, 1,076 (No. 121) contained 1·47 grain of arsenious oxide per gallon. The remaining five samples had an original gravity of 1,063·4°; in one the arsenious oxide amounted to 1·40 grain per gallon, whilst in the other four it varied between 0·94 and 1·13 grains per gallon. Generally, however, the original gravity of the beers was much lower than those just mentioned, and in a large proportion of the whole number lay between 1,040° and 1,057° with an average of about 1,055°. After the evidence which has been given before the Commission, it is unnecessary to further prove that the serious arsenical contamination of these beers was due to certain of the sugars employed in their production. The results of the examination of such sugars are given in Tables III. and V., and, as bearing upon the proportion of arsenic found in the beers, it is only necessary here to allude to the very varying proportions in which sugar was employed. The highest proportions of sugar to malt and grain used were 50 per cent. and 47 per cent. respectively, of the total brewing materials, and in neither case did the arsenious oxide ex

Highest ratio of sugar to malt in arsenical beers on which rebate claimed.

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ceed 0·60 grain per gallon, but such proportions of sugar were exceptional. The lowest proportions of sugar were less than 1 per cent., and in two out of three of these the arsenic found in the beer was 0·05 grain of arsenious oxide per gallon, though in the third case (Expt. No. 67) it amounted to 0·22 grain per gallon. The average proportion of sugar used in the production of these beers was 8 per cent., and in the two beers showing the highest degree of contamination the proportions were 16 per cent. and 18 per cent. respectively. In many cases, however, the sugar employed was obtained from more than one firm, and no evidence has been obtained at the Government Laboratory that the brewing sugars generally in use during the past year were contaminated with arsenic. No sample of malt known to have been used in the production of these beers has been obtained, but the proportion of arsenic found in malts in use in various parts of the country between June and November I refer to later.

Arsenic in Non-Bostock beer.

7864. (*Dr. Whitelegge.*) In Table I. in some instances there is nothing said about sugar. Does that mean that no sugar was used, or that the information is not available?—In the production of all of these beers sugar was used.

7865. In Note 7 to that table: "It was alleged that the contamination was traced by the brewers' chemist to the malt," and I see by the table that in that case the amount of arsenic found was 0·34 grains per gallon. May we take that as well authenticated?—We can only state the facts. These particular beers were brewed in January of this year.

7866. At all events, the glucose in that instance was from a source we had not had associated with arsenic so far?—That is so.

7867. I suppose, as a matter of fact, if one went carefully through this table looking, not to date of brewing, but to locality of the breweries, the quantities of arsenic would be found to vary a great deal—for instance, the Birmingham results vary a good deal?—The greater number of these happened to be strong beers. I emphasised that point. Obviously the proportion of material in a strong beer is greater than in a weaker beer, and you might reasonably expect if part of that material is arsenical you would get a larger arsenical content.

7868. Bearing in mind those local differences, are we quite on safe ground in assuming from the figures you give us that there was a general increase in arsenical contamination month by month?—It seems to me there was certainly an increase of arsenical contamination up to July. After July the increase was not very considerable. Although there are a large number of cases where more than a grain per gallon was shown, if you work it out on the total number of samples the percentage is pretty much the same. From July to November a fairly steady average is obtained—·33 to ·50—but there are an increasing number of instances of the higher quantities—that is, above a grain per gallon. In September there was one, in October two cases, in November there were seven cases, with one at 0·94. But as a percenage on the total number of samples examined the difference was not great—that is, the percentage of those over one grain was 11, 13, and 10 for the three months I have given you. So that one must make allowance for the larger number of samples when one fixes one's eyes on the larger quantities found.

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Arsenic in sugars forwarded to Government Laboratory.

7869. (*Chairman.*) You have evidence as to the amount of arsenic contained in brewing materials, based on the examination of samples forwarded to the Government Laboratory by Excise officials?—Among the samples sent for examination in connection with the arsenicated beers there were three unfermented sugar solutions which were found to contain arsenic equal to 7·99, 8·14, and 2·62 grains of arsenious oxide per gallon. These were priming solutions prepared on the 23rd, the 28th, and the 24th November respectively, the first two from invert sugar and "fluid" sugar respectively, both manufactured by Bostock and Company, and the third, which was described as "black priming solution," from equal quantities of Bostock's invert sugar and of caramel from a maker whose name could not be ascertained. The calculated proportions in grains of arsenious oxide per pound of sugar used were 1·66, 1·74, and 1·09 respectively, the last being calculated on the invert sugar alone. Three samples of invert sugar and one sample of solid glucose, all stated to be of Bostock's manufacture, were also sent for examination in connection with the applications for repayment of duty on the destroyed beer. The three samples of invert sugar were found to contain arsenic equal to 2·04, 1·83, and 1·67 grains of arsenious oxide per pound respectively, whilst the quantity in the solid glucose was 1·99 grains per pound. Samples of solid and liquid caramel used in brewings of arsenical porter and stout were found to be free from arsenic, and it was stated that these were not obtained from Messrs. Bostock. All these results are embodied in Table III.

TABLE III.—PROPORTION of Arsenious Oxide found in Brewing Sugars forwarded for examination in connection with samples of Beer known to contain Arsenic.

Progressive Number.	Date of Sampling of Sugar or of Preparation of Solution.	Description of Sugar.	Proportion of Arsenious Oxide.		Vendor or Manufacturer of Sugar.
			Grains per pound of Sugar.	Grains per gallon of Solution.	
	1900.				
1	Nov. 23	Priming solution of invert sugar	1·66 =	7·99	Bostock & Co.
2	„ 24	Black priming solution prepared from equal quantities of invert sugar and caramel	1·09 = (calculated on invert sugar alone.)	2·62	Invert sugar from Bostock & Co. Caramel from another source (unknown).
3	„ 28	Priming solution of invert sugar	1·74 =	8·14	Bostock & Co.
4	„ 30	Invert sugar	2·04	–	Ditto.
5	Dec. 5	Ditto	1·83	–	Ditto.
5	„	Glucose	1·99	–	Ditto.
	1901.				
7	Jan. 25*	Invert sugar	1·67	–	Ditto.
8	„ 25	Solid caramel	Nil.	–	–
9	„ 25	Liquid ditto	–	Nil.	–

*Kept over at Brewery from November (unused).

7870. You have also evidence as to the amount of arsenic contained in brewing materials based upon the examination of samples forwarded to the Government Laboratory by Excise officials for the determination of brewing value?—The sugars we have already dealt with were directly connected with the arsenical beers alluded to in Table I. The samples I am now going to allude to were sent up previous to the detection of arsenic in beer, and were forwarded from various parts of the country by Revenue officials. As regards the samples of brewing materials forwarded by Excise officers to the laboratory, it may be stated that as a rule these samples are preserved for three months after receipt, and at the end of that time, unless otherwise ordered, are destroyed, storage for a longer period being impossible on account of the large number and variety of articles received for examination. On the discovery of the arsenical contamination of beer all the brewing materials in store or under examination were placed aside to be tested for arsenic, and 104 samples of sugar with 48 samples of malt have since been examined. The sugars included samples taken at breweries in each of the months from June to November, and the total was made up of 64 glucoses and 40 invert and priming sugars. Of these six samples of glucose and two invert sugars were found to contain arsenic. These samples are classified in Table IV. In four instances the proportion of arsenic was found to be larger than that in the sugars obtained for examination in connection with the arsenicated beers, particulars of which have been already given. All the arsenicated samples were drawn from the North of England, and with one exception were probably of Bostock's manufacture, whilst only a small proportion of arsenic was found in this excepted instance. The full particulars as to these contaminated sugars are shown in Table V, whilst in Table VI. a list of places is given from which the non-arsenicated sugars were drawn. Fourteen samples of glucose and six samples of invert sugar taken from breweries during March of this year were all found to be free from arsenic.

Arsenic in Non-Bostock beer.

TABLE IV.—PARTICULARS as to Brewing Sugars forwarded by Excise Officials for Examination as to Brewing Value, and afterwards Tested for Arsenic.

Month in which Sampled at Brewery.	Number and Description of Samples.		Number of Samples found	
	Glucose.	Invert and Priming Sugars.	Free from Arsenic.	Containing Arsenic.
June 1900 - - -	4	3	6	1
July „ - - -	8	4	10	2
Aug. „ - - -	5	4	8	1
Sept. „ - - -	14	17	28	3
Oct. „ - - -	9	6	15	Nil.
Nov. „ - - -	24	6	29	1
	64	40	96	8

Note.—Particulars as to the above arsenicated sugars are given in Table V., and a list of places from which the non-arsenicated sugars were drawn appears as Table VI.

TABLE V.—PARTICULARS as to the Brewing Sugars shown in Table IV. as having been found to contain Arsenic.

Progressive Number.	Date of Sampling.	Place of Sampling.	Description of Sugar.	Arsenious Oxide found.	Vendor or Manufacture of Sugar.
				Grains per lb.	
1	June 29, 1900 - -	Chester - - -	Glucose -	1·21	Bostock & Co.
2	July 10, „ - -	Liverpool - - -	„ -	1·44	Uncertain.
3	„ 19, „ - -	Ardwick, Manchester -	„ -	·89	Bostock & Co.
4	Aug. 8, „ - -	Liverpool - - -	„ -	3·28	Ince, Pickering & Co.
5	Sept. 4, „ - -	Blackburn - - -	Invert sugar	3·21	Bostock & Co.
6	„ 12, „ - -	Oldham - - -	„ „	3·09	Bostock & Co
7	„ 15, „ - -	Bardsley - - -	Glucose -	2·67	Ince, Pickering & Co. ("probably Bostock's manufacture").
8	Nov. 8, „ - -	Longtown, Cumberland	„ -	·09	Paisley Sugar Company, St. Mirren's Works, Paisley.

Note.—In connection with the arsenical beers shown in Table I. it has been mentioned that the sugar sold by Messrs. Ince, Pickering and Co. was manufactured by Messrs. Bostock and Co

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TABLE VI.—List of Places from which Samples of Brewing Sugars found to be free from Arsenic were obtained in the Months from June to November, 1900.

ENGLAND AND WALES.

Appleby.	Newark.
Birmingham	Newport (Isle of Wight).
Blackburn.	,, (Salop).
Bradford-on-Avon.	Northampton.
Brocklampton.	Norwich.
Bury St. Edmunds.	Nottingham.
Calne.	Old Basford.
Canterbury.	Oldham.
Caerleon.	Ormskirk.
Carlton.	Penrith.
Cardiff.	Perry Bar.
Chard.	Petersfield.
Colne.	Pontardawe.
Crangoose.	Rugby.
Crumpsall.	Rye.
Daybrook.	Scarborough.
Derby.	Shelton.
Ditchingham.	Sherburn.
Dolgelly.	Sidmouth.
Hartlepool.	Smethwick.
Hastings.	Somerton.
Hayle.	Stambourne.
Heckmondwike.	Stow-on-the-Wold.
Helston.	Stroud.
Hitchin.	Tadcaster.
Ironbridge.	Taunton.
Kimberley.	Thornton-le-Moor.
Leemingbar.	Walmersley.
Leeds.	Wakefield.
London.	Wavertree.
Lowestoft.	West Bromwich.
Malton.	Wetherby.
Manchester.	Willenhall.
Market Drayton.	Wolverhampton.

SCOTLAND.

Aberdeen.	Glasgow.
Broughton Ferry.	Montrose.
Craig Millar.	St. Andrews.
Dumbarton.	

Meaning of "freedom from arsenic" when applied to sugar,

7871. (*Chairman.*) What does "free from arsenic" mean at the Government Laboratory? Does it mean free from arsenic which can be separated and weighed from a litre of beer or from 100 grammes of sugar, or do you apply a qualitative test as well?—It means such a quantity of arsenic as is not shown by the Marsh test when tested upon 20 grammes of sugar.

7872. The test from 100 grammes of sugar would be analogous to the test from a litre of beer?—It would.

7873. If it has been declared free from arsenic by the Marsh test on 20 grammes of sugar?—That is so.

and to beer.

7874. And as regards beer, when has that been declared arsenic free?—When the Marsh test showed no reaction for arsenic with not less than 50 cc.

7875. Can you say how much arsenic there might be in a gallon of beer escaping that test?—There is no evidence that there is any.

7876. If there was 1-100th of a grain of arsenic per gallon would it be shown?—Readily.

7877. 1-200th?—Then it becomes doubtful.

Maximum amount of sugar which might be used in beer

7878. (*Professor Thorpe.*) What amount of sugar could there conceivably be in a litre of beer, used in the fermentation or in the priming?—Taking 1,080°, which is very strong beer, 20 grammes per 100 c.c. or 200 grammes per litre, supposing the whole of the gravity to be due to sugar.

7879. Assuming that the beer had a mean density of 1055°, what is the maximum amount of sugar that could be used in the formation of that beer?—1·77lb. per gallon.

7880. How much would that be in a litre?—Roundly, it would be 142 grammes of sugar per litre of beer at 1,055 gravity.

Quantities of arsenic found in malt.

7880a. (*Chairman.*) With regard to malt taken from breweries during the months from June to November of last year, you say that all but six afforded evidence of the presence of arsenic, but the highest proportion of arsenic was only 0·05 grain of arsenious oxide per pound of malt?—That is so.

7881. In 22 samples the arsenious oxide per pound of malt lay between 0·05 and 0·02 of a grain?—Yes.

7881a. And that in 19 cases, whilst still showing traces, the quantity was less than 0·02 per pound of malt?—That is so.

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7882. Of the malt samples received during the month of March three contained from ·05 to ·02 of a grain of arsenious oxide per pound, five contained traces amounting to less than ·02 grain per pound, and one only was quite free from arsenic?—That is so.

Amount of malt which may be used in all malt beer.

7883. (*Professor Thorpe.*) Can you tell the Commission how much arsenic there would have been in a litre of beer if the whole of that beer had been brewed from malt, and the amount of arsenious oxide in the malt used was the maximum? You found ·05 of a grain per pound of malt. How arsenicated would that beer be, assuming that the whole of the arsenic went in?—·16 of a grain per gallon if the whole of the arsenic present in the malt to the extent of ·05 grain per pound had gone into the beer.

7884. Are you quite right there?—I think so. It is below what has been said by Dr. Campbell Brown, for instance, to have been found in an all-malt beer.

7885. How much malt goes to a gallon of beer, roughly speaking?—2·33lb. I said ·16, but it is really ·116.

7886. (*Chairman.*) 2·33 times ·05 is ·12 nearly?—Yes, ·116 exactly.

No evidence of selenium in Bostock sugars,

7887. You have evidence as to the presence or otherwise of selenium in brewing sugars obtained at various times during the past ten months?—In view of the possibility that brewing sugars prepared or treated with sulphuric acid might possibly contain selenium, it was felt to be necessary that search should be made for this substance. The samples of solid sugar and of prepared sugar solutions which had been used in the preparation of beers proved to be arsenicated were first examined. These samples were received directly from the breweries, and full particulars as to the description of sugar, arsenical content, date of sampling, etc., have been given in Table III. In no case was any selenium found to be present in the sugar or sugar solution. The sugars enumerated in Table V. were next examined, and were also found to be free from selenium. These samples include all the sugars found to be arsenicated of those sent for examination by Excise officials throughout the United Kingdom between June and November last. Finally, a selection of the non-arsenicated sugars forwarded for examination from various parts of the country between June and March last were tested for selenium, but in these samples also no selenium could be detected. It should perhaps be stated that when traces of selenious acid were added to glucose or invert sugar the presence of selenium was readily demonstrated. No evidence of the presence of selenium in brewing sugars—glucose or invert—has therefore been obtained at the Government Laboratory.

or in other sugars.

7888. You have evidence also as to the presence or absence of arsenic in imported brewing sugars?—The samples of brewing sugars obtained from various parts of the country, and classified in Tables V. and VI., probably represent with a very considerable degree of completeness the whole of the sugars, whether of home or foreign manufacture, in common use by brewers in the United Kingdom. To render the investigation even more thorough, however, samples of brewing sugars were taken by the Customs authorities from importations extending over a month. One hundred and seventy-seven samples in all were received, consisting of solid and liquid glucose, caramel and syrups, described as 'molasses." These samples were received from the United States of America, Germany, Belgium, Holland, and Canada. With two exceptions, all these samples were found to be free from arsenic. The two samples in which evidence of arsenic was obtained consisted of liquid glucose, imported, at London and Hull, respectively, in both cases from Stettin. The amount of arsenic was small. The exact quantities in the two instances are ·02 and ·01 grain per pound respectively.

Arsenic in German glucose.

7889. Were these samples from Belgium, Holland, and Canada made in those places?—We cannot say. We only know that they were imported from there. Certain marks are on the packages, which, on investigation, might possibly lead to some information being obtained, if the Commission deem it of importance.

7889a. (*Professor Thorpe.*) The Customs will have no information?—No.

7890. In the case of Holland and Belgium, for instance, it might be German glucose which came down the Rhine?—I think so.

7891. (*Chairman.*) Are these imported sugars all glucose?—They were glucose, caramel, and other sugars, which are imported according to the Customs regulations, as molasses, that is to say, they are of the character of treacle.

7892. With regard to the evidence of the presence or absence of arsenic in beer supplied by Government contractors for Army and Navy use, have you anything to say on that?—All samples of beer supplied under Government contracts which have been submitted for analysis since December last have been examined for arsenic. Forty-six samples of this class have been received, and 45 of these were found to be free from arsenic, whilst one War Office sample contained about one-hundredth of a grain of arsenious oxide per gallon (·011 grains), and was so reported.

7893. Do you, as a matter of routine, have beer intended for Army and Navy use sent to you for examination?—Not quite as a matter of routine, but samples come frequently at rather irregular intervals, taken as those in charge of the contracts, or the inspecting officers, deem necessary.

7894. To test for quality?—Yes.

7895. And for freedom from noxious substances?—That has been included.

7896. Did you ever test them for arsenic before the recent outbreak?—No.

7897. (*Professor Thorpe.*) These beers for the Government service, whether for the Army or Navy, are tendered according to the specification of gravity, etc., and it is your duty to see how far the beers conform to the specification?—Yes.

7898. As a matter of fact we have under consideration now the revision of the terms of the specification, in view of this scare?—Yes.

7899. (*Dr. Whitelegge.*) In the event of any mischief being associated with beers supplied for the Army or the Navy, would samples come to the Government Laboratory for examination?—We have had one case of vinegar some three or four years ago. There was a case of poisoning at Portsmouth. They did not know what was the cause, but vinegar was stated to have caused the illness of 17 men. I directed it should be searched, for second group metals, which include lead, arsenic, and copper, and we readily found arsenic in fairly considerable quantity. Samples of the vinegar were afterwards sent as received direct from the vinegar manufacturer, and those samples of vinegar were found to be quite free from arsenic. That is the only case we have had.

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Arsenic in vinegar at Portsmouth.

7900 (*Chairman.*) Was there any explanation of how the arsenic got into the vinegar in that special case?—The military officials had an inquiry, but it was never published, and we are not acquainted with the result arrived at.

7901. How much arsenic did you find?—A very large amount; 230 grains, if I remember rightly, but I should like to refresh my memory.

7902. (*Chairman.*) That could not be a mere accident?—No, it was malicious.

Added maliciously.

7903. (*Dr. Whitelegge.*) There has been no recent occurrence of illness amongst troops or sailors attributed to beer, which has come to your notice?—None whatever.

7904. Was not there something of the kind last year amongst volunteers in camp somewhere?—I have a faint recollection of having seen something, but I am afraid I cannot recall the exact particulars.

7905. If there had been arsenic found you would have known of it?—Yes.

7906. (*Chairman.*) If we have any further questions to ask on any of the evidence which will be before us in print, we may perhaps wish to see you again?—I shall be quite prepared to attend.

SEVENTEENTH DAY.

Tuesday, 21st May, 1901.

PRESENT:

The Right Hon. Lord KELVIN (in the Chair).

Sir WILLIAM CHURCH.
Professor THORPE.
Mr. COSMO BONSOR.
Dr. WHITELEGGE.

Dr. BUCHANAN, *Secretary.*

Mr. OTTO HEHNER, called; and Examined.

7907. (*Chairman.*) You are public analyst for Nottinghamshire, West Sussex, the Isle of Wight, and the boroughs of Derby and Ryde?—Yes.

7908. And past President of the Society of Public Analysts and Chairman of the London section of the Society of Chemical Industry?—Yes.

7909. You have given considerable attention to the question of arsenic in ingredients of food and in commercial products?—I have.

7910. Will you kindly tell the Commission what you have found?—I have analysed a very great number of samples of beer from different parts of the country, also malts and chemicals which are used in the manufacture of beer, and, as a general experience, I may say, that it is exceedingly rare that I find a sample of beer which is totally devoid of arsenic. The same thing applies to malt. I doubt whether I ever found a single sample of malt which is totally free from arsenic. I would draw from that the conclusion that whilst the present system of malting and brewing is in practice, it is impossible to expect a beer to be quite free from arsenic.

Mr. O. Hehner.
21 May 1901.

7911. You speak of the present system of malting; but what characteristic of the present system do you refer to?—To the system of malting where the fumes of coal come in contact with the malt. Of course, on the Continent, malting is largely on an entirely different system of drying from what is in this country, and a system which is not, under present circumstances, applicable in England.

7912. Why should it not be applicable in England?—Because it would mean the reconstruction of all the malting ovens, which is rather a large order at the present time. I think gradually there might be a change unless meantime other means are found to retain the arsenic in coal. I have every hope that partly by careful selection of the fuel and partly by chemical treatment of the fuel, arsenic will be kept out of malt much more than hitherto has been the case. Already, as far as my experience goes, most maltsters are exceedingly careful in the selection of their fuel, which was not the case a few months ago, and methods are being tried with the intention, and, I think, with every hope, of retaining the arsenic in the coal. It is a very curious fact that in the burning of the coal or

How arsenic in beer may be reduced.

Treatment of malting fuel in order to fix the arsenic.

Mr. O. Hehner. 21 May 1901.

coke, the arsenic does not entirely, or only to a small proportion, volatilise. One would imagine that arsenic was volatile at the high temperature of a furnace with a reducing agent present, but as a matter of fact the bulk of the arsenic remains in the ash, and I believe it is practicable or probable that the rest of the arsenic can be also retained. Therefore I say under the present conditions of malting I think you cannot expect freedom until some change has been brought about either in the mode of drying or in the mode of combustion.

Most of arsenic in coal remains in the ash.

7913. Have you ever analysed the ash of various kinds of coal for arsenic?—Yes. I have never found one free. I have made quantitative determinations of the proportion of arsenic which is left in the ash, and the proportion which is volatile, and by far the greater portion, sometimes as much as 9-10ths, remain in the ash, and only 1-10th goes away, but sometimes more is volatile, although the bulk remains in the ash.

7914. Does it remain in the ash in a form from which it would not volatilise if heated to redness for instance?—It will not volatilise. I do not know in what form it may be, whether arsenate or arsenite of iron, but it is not volatile and not reducible by the carbon into elementary arsenic which would go away. But of course in a malting furnace there is always a considerable amount of coal dust flying about, and that dust is always arsenical.

7915. You consider that it is in combination with iron in the ash?—I have no direct evidence; one can only form ideas about it. I have no evidence whatever.

7916. Do you think there is any other objection than the expense to the Continental method being introduced into England?—I have not sufficient knowledge of the practical requirements of the brewer, and I can only say from hearsay, which is not worth much, that the Continental system of malting has been tried here, and has not given very good results. I, personally, know nothing about it.

7917. You do not know in what respects the results were inferior?—The suggestion is that the flavour of the smoke, as produced by the coal fumes, is required in English beer.

Continental system of malting.

7918. Can you describe the Continental method of drying the malt?—The malt is dried on impervious floors, metal floors often.

7919. Flat floors?—Yes, as far as I know.

7920. Are those floors heated?—Yes, by flues underneath, or by a double floor where the products of combustion of the furnaces go through.

7921. Do you know to what temperature the solid floor is heated?—I do not.

7922. Is the floor iron or stone?—When I knew it it was iron, but I am not a practical maltster, and I can hardly presume to give definite evidence on the point.

7923. Would any special arrangement be made for a current of air to be driven through the malt?—I do not know.

Traces of arsenic in refined sugar

7924. You have found minute traces of arsenic in some kinds of sugar?—Yes. I have examined numerous samples of sugar, and I have found them mostly to be free from arsenic, but in a number of cases I found even in refined sugars exceedingly minute traces, but still quite plainly discernible. The same applies to molasses, the refuse from sugar refining, and there I found in a few cases minute traces of arsenic.

7925. When you say "minute traces of arsenic in sugar," about how much would that be?—I think up to about ·005 grains per pound; 1-200th of a grain per pound.

and molasses,

7926. And in molasses a greater quantity or about the same?—About the same.

in sodium carbonate and sulphites

7927. You found arsenic in some other substances—salts of sodium and potassium?—Sodium carbonate almost invariably; potassium carbonate almost invariably; sulphites, traces and more than traces.

7928. Larger quantities sometimes in sulphites?—Sometimes, but at present, where a great deal of attention has been drawn to it, the quantities are exceedingly minute, but absence, I think, cannot be insured.

in borax.

7929. Borax?—Yes, I have found considerable traces.

7930. About how much?—I have never determined it.

7931. Oxide of iron?—Yes, I should say in sulphate of iron sometimes very definitely, and in oxide of iron, which is obtained from sulphate, and used for colouring of chocolate and bloater paste, and so on, very strong traces of arsenic, up to 1-10th or more grains per pound—in oxide of iron which resulted from the heating of the sulphate of iron.

Mr. O. Heh. 21 May in oxide iron.

7932. These articles are all used for food materials?—Yes.

7933. Do you think the arsenic which may thus be introduced into the food is liable to be in poisonous amounts?—I think not. What I wish mainly to point out is, at present it is not reasonable to expect absolute freedom. I would wish that beer and food material could be free, but I do not see the possibility. I take, as an analyst, the greatest pains to get arsenic-free materials, and it is almost an impossibility. Even when I get from the very best makers pure so-called arsenic-free acid, I, as a rule, have to subject it to a further process of purification, and even when pure one day it may be impure the next, because I have found, with a number of my colleagues, that hydrochloric acid especially takes up arsenic from the glass bottles in which it is stored.

Absorpti of arseni acids fro glass bot

7934. Is there arsenic in the composition of the glass?—Of much glass, of white glass, as a rule; also of blue Winchester quart bottles. I have found in several cases acid quite pure stored in Winchester quarts has got arsenical from an analytical point of view, not to an extent capable of producing ill effects.

7935. Do you refer to hydrochloric acid, sulphuric acid, or both?—To both, but mainly to hydrochloric acid. Hydrochloric acid seems to attack the glass more than sulphuric.

7936. Have you any suggestion as to sulphuric acid brought into commerce?—I think that no sulphuric acid should be sold unless it has been subjected to a de-arsenicating process, or unless it is labelled "arsenical." There is, I believe, no great difficulty and no great expense connected with the practical removal of arsenic from sulphuric acid and manufacturers not using it in their own works, I think ought to sell it after it has undergone a de-arsenicating process, because the makers of sulphuric acid are comparatively few, while the users of sulphuric acid are many.

7937. With regard to sulphuric acid made from Sicilian brimstone, should you say that required de-arsenication?—From what I have said before, it follows that I do not mean the complete removal, which, I believe is from an analytical point of view commercially impossible, but it should not contain more than a certain quantity, to be laid down. In that case I should think that Sicilian brimstone-made acid would require in most cases no purification, although it may contain traces of arsenic.

7938. If acid is not arsenic-free in the sense you have explained, do you think notice should be given by the vendor?—I think it should be labelled. I think the notice should be incumbent on those who sell arsenical acid, not on those who have subjected it to a process. At present, if you buy acid, and you obtained a bottle labelled sulphuric acid, it is almost certainly arsenical. If you want it pure you get a separate label "free from arsenic," or "freed from arsenic." I think it should be the contrary. Sulphuric acid should be pure unless the contrary is notified.

Arsenical sulphuric acid shou be labell such.

7939. Sulphuric acid not free from arsenic should be labelled "not free from arsenic"?—Yes, within limits to be laid down.

7940. Are you of opinion that a maximum limit should be laid down in respect to freedom from arsenic of any brewed beverage?—Yes, I think from my experience in most cases now the amount of arsenic is somewhat less than 1-100th of a grain per gallon, and I think from the experience I have collected both from analytical examination of beer and from experience with brewers, that 1-100th of a grain per gallon need not be exceeded with reasonable care. When I calculate it back to malt, that would come to about 1-100th of a grain per pound in the malt, and I do not think that need be exceeded. In fact, it might be somewhat less at the present time.

Maximu limit of permissib arsenic should be laid dow

7941-2. In the case of beer and beer ingredients, a Committee of the Society of Chemical Industry is now engaged, I believe?—Yes, we have appointed a Committee, mainly with the view to settle upon a process for the detection and approximate estimation. We are all convinced that absolute freedom cannot be obtained, and that therefore limits will have to be laid down,

and we are anxious to find a method which shall be easily applicable and reasonably accurate, which could be adopted by all persons concerned.

7943. Can you give any provisional information or opinion regarding tests for arsenic?—I can give no official information, because the Committee has not arrived at a conclusion. I could give my own working and my own opinion, but I do not know whether that is worth having any more than that of any other analyst who has concerned himself with the question. I have personally always employed the Marsh method direct to the beer, working on very small quantities of beer, hardly ever using more than 10 cc. There are hardly any beers where in 10 cc. I cannot find a feeble trace of arsenic under rigid test conditions. I think this test when carefully carried out is the most sensitive and, for quantitative purposes, dealing with traces, the most accurate which we could wish to have.

7944. Better than the Reinsch test?—Yes, much better. The Reinsch test first requires a large quantity of beer, and is not so sensitive. In the second place it is not applicable to certain ingredients. For instance, when we have to deal with the cane sugar or a product of the inversion of cane sugar containing levulose, that, under the influence of the large amount of acid used in the Reinsch test, carbonises, deposits a large quantity of humus matter, which prevents the copper from attacking the arsenic. In fact, an arsenical sugar gives no Reinsch reaction.

7945. Have you tried the Bloxham electrolytic method?—No.

7945. Have you any opinion to express regarding it?—No.

7947. (*Sir William Church.*) Have you examined any foreign beers?—Yes, a few.

7948. Were they entirely free from arsenic?—Yes, entirely. I sent for some bottled beer, and I obtained some quite free, which gave no reactions under the conditions where I got a reaction in English beer.

7949. You do not, of course, know how the malt was prepared that the beer was brewed from?—No, and my experience with foreign beer is quite small.

7950. You have in your mind some way in which you think the whole of the arsenic might be retained in the ashes of the coke?—Experiments are being made at present with a process based on the same principle as that which was in use a good many years ago, to retain sulphur in coal and coke, which depended on the liberal addition of lime to the coal, which fixed all the sulphur, and I believe retains much of the arsenic. Whether it will do so fully I cannot say yet.

7951. That is not likely to be a process which would give off fumes which might be found prejudicial from a commercial point of view to the malt?—I should think not. I should think it would retain the sulphur and possibly other acid products of oxidation. But I think a considerable amount of the arsenic in malt is due to the coal ashes which fly up, and that seems proved by the fact that if I take a malt and determine the arsenic in it, brushing it well and cleaning it, as a rule the arsenic much diminishes.

7952. That might arise from the deposit of volatilised arsenic upon it?—It might, but when one thinks of the immensely small quantity, especially as the malt at first is moist and arsenic will stick to it, I think it is unlikely.

7953. The quantities that you found in these other materials, caustic soda, sulphurous acid, and sulphites, and so forth, although you say you are not a doctor, they are really such small amounts that they are quite negligible?—Especially those things like sulphites; no large quantity can be taken. In the case of oxide of iron, which I may find in connection with the colouring of confectionery, the amount of arsenic seemed to me sometimes appalling. A small pen-knife point sample of the substance gave actually innumerable stains by the old Marsh process, not by the Berzelius Marsh modification. I could obtain stains of arsenic from a very tiny quantity of oxide of iron. Knowing that oxide of iron may go into bloater paste, I have obtained a good many samples of bloater paste, but I could not trace any arsenic in them. But I do not think arsenical oxide of iron should be used in food.

7954. That is, used as a colouring material?—Yes.

7955. Do you know if it is used as colouring material in confectionery?—Yes, chocolates.

7956-8. (*Professor Thorpe.*) Have you had occasion to examine the dust from malt?—Yes, a few.

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7959. But only for the arsenic?—Never for anything else but arsenic.

Volatile arsenic in coal.

7960. You have not pushed your examination so far as to satisfy yourself it actually was coal ashes?—No. I think such an endeavour would meet with many difficulties because the dust brushed from malt is largely organic matter from the malt itself.

7961. But the determination of the ratio of the silica to the oxide of iron and lime would enable you to know whether it was actually coal dust?—It might. Many of my friends have taken samples of ashes from all parts of the malt houses, and it is plain in places where there can be no malt dust or probably there is none, that the arsenic is always present, and is in the form of coal ashes.

7962. I think the general impression which the Commission has gained from the evidence which has been presented to it is, that the arsenic has been deposited on the malt rather in the form of volatilised arsenious oxide?—That was the early impression we all had, that arsenic volatilised very readily from the coal or coke, and of course it would condense when it came in contact with the moist or cold malt. But since we know, quite contrary to most people's expectation, that most of the arsenic is not volatile at all, I think it alters matters more or less.

7963. If it is in that condition, how would you get it into the mash tun in a soluble condition?—There is undoubtedly some in the soluble condition. I have made experiments on malts. I can wash some arsenic off with water alone, and by washing with water and filtering, I obtain an arsenical reaction. But one obtains a larger quantity if one washes the malt with hydrochloric acid. It is not all in the water-soluble condition.

7964. But the impression which one gains from your evidence would be that if the arsenic be in the coal dust in the form of a presumably basic arsenate of iron, or perhaps arseniate of lime, it would be in an insoluble condition?—Yes, much of it.

7965. The greater portion of it?—That which is in form of ash.

Solubility of sulphide of arsenic.

7966. Therefore, when the malt is mashed, by far the larger proportion of the arsenic would remain insoluble?—Of course, we have to deal with such small quantities that it is very difficult to be able to say, because a substance is insoluble, that therefore it would not go into solution; we would call arsenic sulphide insoluble, but we know it is soluble to the extent of, say, one in a million.

7967. The direct determinations you have made of the amount of arsenic in the fuel and the comparative estimations you have made of the amount of arsenic in the ash serve to show it must be in such a condition that it must remain insoluble?—That which is in the ash I believe remains mainly insoluble, but not all the arsenic is insoluble. There is a portion which is actually volatile, and which I believe to be present in the malt in the form of arsenious acid.

7968. What I want to get from you is that the amounts which are present in the malt, especially in those malts which have been treated with dilute acid, as in many cases they have, preparatory to the examination being made, do not really give us any clear idea of the amounts which might go into the beer?—No. If the chemist obtains a sample of malt from a maltster, he determines the total arsenic which he can obtain from it.

7969. You rather led me to believe that at least 9-10ths or some such amount remains insoluble?—No. I hope not; not in the malt. Nine-tenths or thereabouts of the total arsenic in the coal is in the ash. I do not suggest all the ash goes into the malt. On the contrary, no doubt in most cases a fraction, say 1-10th, burns off, and probably is in the malt in the form of arsenious acid.

7970. But the larger proportion is in the form of this basic arseniate of iron or insoluble compound which must be insoluble?—In the coal ash, but not in the malt.

7971. What makes it soluble in the malt?—That insoluble stuff is in the coal ash, and the coal ash would not reach the malt otherwise than as dust, the bulk of the ashes remaining behind in the furnace.

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7972. But such portion as does go still remains insoluble?—I suppose it would.

7973. (*Chairman.*) Have you ever filtered beer before testing it for arsenic?—Never.

Sediment of beer, more arsenical than the liquid.

7974. Have you ever examined the sediment in the bottom of a beer cask or bottle?—Yes; I have examined the sediment, which is mostly yeast, and yeast as a rule is more arsenical than the liquor from which it is deposited. Whether that is a matter of precipitation or the yeast assimilates the arsenic and then concentrates it, I do not know.

7975. Have you found arsenic in the deposit from beer in bottles or cask?—Not in bottles, but in casks.

7976. Can you give any idea of what quantity there may be in the sediment of a cask?—No; I do not know.

Arsenic may disappear from beer on keeping.

7977. In a beer in which there is no arsenic discoverable or only a minute trace, may there be a sediment more contaminated with arsenic?—I am afraid I cannot answer the question generally; I have too little experience to say. But in a few cases I have had sediments from beer where in the sediment the arsenic was easily discoverable, and many other chemists have found that the yeast deposited from the wort is more arsenical than the wort itself. I may say, on the other hand, there is often a disappearance of arsenic. I have had samples of beer in which I have carefully determined the arsenic and re-examined them after some weeks, and the arsenic was completely gone. The same applies to exceedingly dilute standard solutions, and the arsenic can vanish entirely from these.

probably is volatilised.

7978. In that case it must be deposited?—I do not know. I think it is volatilised. It is well known that certain fungoid growths, penicilliums, can volatalise arsenic, giving off arsenical gases, and that might be an explanation why, in samples of beer when they are kept, the arsenic diminishes.

7979. That must be when they are kept open?—Yes, and when they go bad.

7980. If the arsenic volatilises from beer in a cask, do you think it comes out into the air?—I do not know. I have no experience. I suppose it would not change.

7981. Nothing could get out of a corked bottle?—No.

Arsenic in alkaline carbonates,

7982. (*Professor Thorpe.*) These alkaline carbonates you speak of, do you imagine the arsenic you find in them comes from the sulphuric acid which has been indirectly used?—I believe in many cases it does, but in other cases not. I have some evidence in the case of alkali which has not been made with sulphuric acid at all, and where traces of arsenic could be found.

7982*. From the ammonia soda process?—Electrolytic.

7983. Have you found it in ammonia soda?—I do not think so.

in refined sugar.

7984. (*Mr. Cosmo Bonsor.*) In the refined sugar and molasses where you found the arsenic, have you any idea of the process in which the arsenic got in?—I have no idea. They were a certain kind of German sugars, and most of them were free. I examined a certain sugar product for a large firm, and I found small traces of arsenic, and they, being very careful, submitted every kind of sugar which had gone into their works. They traced it to a particular brand which always contained it, to a particular brand of sugar from a particular refinery, which always contained traces.

7985. (*Chairman.*) Was that West Indian sugar?—No, German beet.

7985. Have you found arsenic in West Indian sugar?—I have never tested it.

7987. Was your test for arsenic made after the outbreak of this epidemic?—Yes.

7988. You had never tested sugar for arsenic before?—Never.

7989. (*Professor Thorpe.*) How do you imagine the arsenic gets into sugar?—It is imaginable it came in by the liming of the sugar. In a lime kiln it is likely, I take it, that lime may retain a good deal of the arsenic from the fuel, and it might then come into sugar.

7989. Is it possible it comes in from the char?—I think it is imaginable, but it is not general.

7991. (*Dr. Whitelegge.*) Have you made any direct experiments on the removal of arsenic by moulds from beer?—I have not made any pure cultures, if you mean that. Of course, it is well known that certain moulds, pernicillium brevicaule, and so on, do evolve arsenious gas. But I had some strongly arsenical beers in the early stages of this poisoning outbreak, and they diminished in arsenic. I kept a number of samples of less arsenical ones aside, and let them get mouldy, and the arsenic in some of them had vanished entirely.

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Disappearance of arsenic from arsenical beer.

7992. Have you any figures to show the amount of arsenic removed in that way?—No, I have no figures with me, but the amount in the original beer was something less than 1-30th of a grain in those samples I put aside.

7993. In some instances the whole of that disappeared?—Yes.

7994. (*Chairman.*) How had it been kept?—They were kept in sample bottles, probably badly stoppered. The beers had gone sour, and were put aside on the shelf.

7995. Glass stoppers?—No, corks. The cork had been pulled out, and no doubt was perforated and damaged.

Question of combination of arsenic with organic matter of beer.

7996. (*Dr. Whitelegge.*) Have you formed any opinion as to the state in which arsenic is present in beer?—No, I have made some experiments to see the state in which it might be present. I had some samples of beer which were highly arsenical, and I tried whether any of the arsenic was in a volatile condition, but none of it was volatile. I distilled and examined the distillate. I found no volatile arsenic.

7997. You have not formed any opinion whether it is an organic combination or not?—I have not formed any. I do not see any way of ascertaining it with the small traces with which we have to deal.

7998. Would you say as a chemist it is unlikely it would be an organic combination?—No, I think very likely it is an organic combination.

7999. Would that mean in chemical combination with an organic substance, or simply that the arsenic behaved differently because of the presence of organic matter?—I can imagine that in a liquid like beer, where there is a good deal of fungoid life going on, the arsenic might entirely go into organic combination.

8000. You gave us some suggestions as to the amount of arsenic which might be regarded as negligible in beer and in malt, 1-100th of a grain per gallon and 1-100th of a grain per pound of malt. Have you any similar standard in mind as regards sulphuric acid?—I have made a calculation which I have not in my mind, but when one calculates how much sulphuric acid might be used in the manufacture of glucose, for instance, say 3 or 4 per cent., it may be that sulphuric acid can be strongly arsenical before it could introduce so much arsenic as 1-100th of a grain into a pound of glucose.

8001. And you would make your calculation with this data?—Yes.

8002. Is the Committee of the Society of Chemical Industry a large Committee?—It is a Committee of 7, I think. It is mainly an analytical committee; it is not a committee to lay down limits of standards, which are expected from this Commission.

Some organic compounds of arsenic would not react to Reinch, but would to Marsh test.

8003. It is a committee of research?—Yes; to get at the best method of determining arsenic and detecting it in different substances. May I add also at the same time that as far as the Reinsch process is concerned the Reinsch process will not discover arsenic in some organic combinations. Cacodylic acids or cacodylates give no Reinsch reaction, whereas the Marsh process shows them as readily as inorganic arsenic.

8004. Are all the members of the Committee working with the Marsh process?—I do not know. Each works at present on his own lines on samples which are made up by some of us unknown to the others, and even the persons who make them up get them changed by the others, so that we are all at present working on samples of unknown composition. We propose to collect all the data and compare them, and select that process which is giving the most accurate results. I know a good many work with the Marsh process.

8005. These researches will be published in the form of a Report, I suppose?—That is the intention.

8006. May we expect that at an early date?—It depends how long the Commission is sitting.

8007. There is no intention to report early?—No, we intend to report as soon as possible, but the Committee is a committee of busy men, and works very slowly.

8008. You are an analyst under the Sale of Food and Drugs Act for several districts?—Yes.

8009. Do you advise the local authorities in these

districts as to the steps they ought to take under the Sale of Food and Drugs Act?—Sometimes.

3010. Not in all cases?—You mean in reference to arsenic in beer?

3011. Speaking generally, do you advise or do you merely deal with the samples they send you?—As a rule, I deal with samples they send me. I carefully refrain from giving any advice as to what they ought to do, because I do not want to pose as a prosecutor, but if they directly apply to me, I give them advice.

3012. And some do apply to you?—Sometimes.

3013. Have you received samples, for example, of the bloater paste of which you told us?—Yes. I advised them as we were searching for arsenic. Some time before this outbreak in beer we were examining many substances for arsenic. There were a number of cases in the police courts against vendors who sold arsenical sodium phosphate, and from that I went a little deeper into the matter and got a large number of drugs collected, and I examined these for arsenic, but I found nothing so serious as was present in that sample of sodium phosphate which was the subject of the police court proceedings.

3014. How much was there in the sodium phosphate?—I do not remember. It was a large quantity; if I remember right, 1 per cent.

3015. You found arsenic in samples of bloater paste submitted to you officially?—No. I found arsenic in samples of oxide of iron which had been sent to me by clients in the trade for colouring food materials, and then I stopped that as soon as I could. I advised them not to use any article of the kind, and wrote to some of my county authorities about the matter suggesting that it might be well to look into it.

3016. But the results were negative?—Yes.

3017. Were the results alike negative in the other samples examined with the same object?—Yes.

3018. You mentioned chocolate and other forms of confectionery?—I have not had any from my districts from the police. I have had some from the trade. The quantities of oxide of iron used are very small.

3019. Are samples of sweets and golden syrups submitted to you?—Yes.

3020. Do you examine them for artificial glucose?—Yes. We have examined golden syrups for some years past for glucose, and there have been very many prosecutions for the sale of golden syrup consisting more or less of glucose, but sweets have practically not been examined for glucose, because the term "sweets" seems to be a very indefinite one, and there are practically no sweets without glucose.

3021. If you find glucose in golden syrup, do you report it as an adulteration?—Yes, and I have reported it as an adulteration in jams. I have had some prosecutions lately against vendors of jams using glucose without acknowledgment.

3022. In any of these cases have you found arsenic?—Never. I found traces of arsenic in sweets, but nothing very serious—in cheap sweets.

3023. Have all your authorities sent samples of beer to you for examination for arsenic?—Yes; all.

3024. Was it the practice prior to the Manchester outbreak to examine samples of beer for arsenic?—No; it never entered anybody's mind.

3025. What is the largest amount of arsenic you found in the beer samples?—1·05 grains per gallon.

3026. How much beer was sent to you as a sample?—As much as I asked for. If I got too little, I would ask them to send more; but, as a rule, I got about a pint.

3027. Did you instruct the officers of the Local Authority as to the amount to be taken as a sample?—No. If I got too little I would say—you must buy more. I always do with as little as I can, because the inspector should purchase samples as much as possible in the ordinary way of family trade.

3028. Are samples of beer still being submitted to you?—Yes; I have some now.

3029. Do you still find small traces of arsenic?—Almost invariably.

3030. But nothing approaching the quantity you gave me just now?—When I have less than one-hundredth of a grain per gallon it is my practice to report to my authorities that it contains, in my opinion, an insignificant trace.

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3031. If it contains, let us say, one-thirtieth of a grain per gallon?—I would report that it contains an undue proportion of arsenic.

Arsenic in beer now brewed,

3032. Would you forward a certificate which could be made the basis of proceedings, in that case?—I would now. I did not at first. At first there were many samples with one-thirtieth of a grain, and when I was asked I suggested the vendor should be notified. In fact, the vendors were treated very gingerly at first, as many of them were quite as innocent as the analysts themselves. But at a later stage they were warned, and prosecutions were instituted in some cases.

and action by authorities under F. and D. Acts.

3033. What is the smallest amount for which prosecutions have been instituted in your district?—I don't know.

3034. Anything less than one-thirtieth of a grain?—No. I believe there have been some prosecutions in Nottingham for about ·05. In many cases I do not know when there is a prosecution; but I have given certificates which could be used for prosecutions. But one-thirtieth of a grain would be rather rough on the vendor, I think

3035. Did all your authorities send samples?—They have, yes.

3036. Varying very much in number?—Yes.

3037. Varying to an extent that cannot be explained plained by the population or any consideration of that kind?—These matters have got very much better in the last few years. The Local Government Board have more sharply looked after counties and districts which do not work the Sale of Food and Drugs Act. It is a very different state of things from what it used to be. There are still a few districts which work reluctantly, but the bulk of them have vastly improved since the Committee of the House of Commons some years ago inquired into the matter.

3038. You mean generally, and not with particular reference to beer samples?—Generally.

3039. Can you say what action the Local Government Board took?—The Local Government Board sent a circular to all authorities, drawing their attention to articles which might contain glucose, and, consequently, arsenic, at an early stage of this outbreak.

3040. That followed the Manchester experience?—Yes.

Position of Local Government Board as to enforcement of F. and D. Acts by local authorities.

3041. But I understood you to refer to something earlier following on a Committee of the House of Commons?—Yes. The Local Government Board for years have been in communication with authorities that do not work the Sale of Food and Drugs Act sufficiently rigorously, in the opinion of the Local Government Board. At that time there existed no power to compel them to work, but now under the new Act of 1899 there is a provision which enables the Local Government Board or the Board of Agriculture to interfere and to take samples at the expense of the Local Authorities.

3042. In default of the local authority has that been done?—I have not heard of a case.

Question of combination of arsenic with organic matter of beer.

3043. (*Professor Thorpe.*) Lord Kelvin desires me to ask you a little more about the organic combinations of arsenic. Have you in your mind anything more clearly as to the form of organic combination of arsenic?—I have not. I believe from the fact that arsenic vanishes from liquid like beer it can only vanish in an organic form. I have never smelt any arsenical odour even in a highly arsenicated beer.

3044. Do you mean you have not smelt anything like diethyl arsine?—No. I have carefully looked out for that and have never smelt anything, and yet the arsenic vanishes not only from the beer, but from a very dilute standard solution when it becomes mouldy. I have taken the mould out of a standard solution, and can trace no arsenic in the mould itself.

3045. But in the *penicillium brevicaule* it was found that the arsenic was assimilated by the mould?—Yes, and ordinary yeast does it. But *penicillium brevicaule* produces a volatile arsenic compound which yeast, so far, is not known to do.

3046. Would the common mould, the other *penicillium*, assimilate arsenic like the *brevicaule*?—I do not know.

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8047. In beer, bread, potatoes, or anything of that kind it is not *brevicaule*?—No; it is *penicillium glaucum*.

8048. In the particular instance you cited where the arsenic disappeared, was there a mould present?—Yes. I have never had any pure culture, and so I have not examined it carefully. On a number of occasions I have had to make standard mirrors for various friends, and, using always the same solution, I noticed that the mirrors were getting feebler and feebler, and on making a fresh solution again, the original mirrors were once more obtained. If I let that solution stand, the arsenic vanished completely from it.

8049. When the arsenic is in the beer, before the mould does its work, do you imagine that the arsenic is in any organic combination?—I should not be surprised if it partly were.

8050. In what form do you imagine it might be?—I do not know. I can hardly give a theory.

8051. But it is not anything analogous to cacodyle or diethyl arsine?—No.

8052. These you tell us would not be recognised by the Reinsch test?—It is not.

8053. These arsenicated beers do give a strong Reinsch reaction?—They do.

8054. Would not that indicate that the arsenic was either in the form of arsenious acid?—Yes. On the other hand, I have made many comparative experiments between the Reinsch and the Marsh, and I always got a stronger indication with the Marsh than with the Reinsch. Whether that is the fault of the process which does not allow the whole of the arsenic to be deposited, or whether it is due to a portion of arsenic being in a condition that it cannot be deposited on the copper I do not know, but the Marsh process gives a larger yield than the Reinsch process.

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8055. In the quantitative estimation of the arsenic do you find it is necessary to break up the organic matter?—No, quite unnecessary. I have made many experiments by adding to beers which were obtained as pure as they could be obtained—in fact, I bought some of these Continental beers about which I was asked, in order to get pure beers—I added arsenic to the beer and recovered it back again by the Marsh process which I use—I got an amount in the shape of a mirror, as if it had been an aqueous solution.

Destruction of organic matter of beer undesirable.

8056. And you think it is not necessary to treat the beer with the drastic method of chlorate of potash and hydrochloric acid?—Not only not necessary, but even dangerous. I know that glass is often contaminated with arsenic, and, therefore, the less drastic the measures are which we have to take, the better.

8057. You mean that the materials used, as well as the glass vessels in which the operation is carried on, may contribute to the amount of arsenic which is found?—They may.

EIGHTEENTH DAY.

WESTMINSTER PALACE HOTEL.

Thursday, 20th June, 1901.

PRESENT:

The Right Hon. Lord KELVIN (*Chairman*).

The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Professor THORPE.
Mr. COSMO BONSOR.
Dr. WHITELEGGE.

Dr. BUCHANAN, *Secretary*.

Mr. CLARE SEWELL READ, called; and Examined.

Mr. C. S. Read. 20 June 1901.

8058. (*Chairman.*) You were Member of Parliament for Norfolk from 1865 to 1885?—Yes, with the exception of a short period in the year 1880, when I lost my election by one vote, and I was out for a few months.

8059. And you took part in the work of the Local Government Board?—I was Parliamentary Secretary to the Local Government Board in 1874 and 1875.

8060. You were Chairman of the Adulteration Committee of the House of Commons in 1875?—Yes.

8061. And you served, I believe, on the Beer Materials Committee?—Yes, for 2½ years, and I attended every sitting of the Committee with the exception of the last two, when they were considering the Majority Report. I heard all the evidence.

8062. You have been engaged in farming for many years?—Sixty years.

8063. You were appointed last April to represent the Central Chamber of Agriculture before this Royal Commission?—Yes, in conjunction with Mr. Henry Stopes.

8064. Have you any scientific knowledge of or practical acquaintance with brewing or malting?—None whatever.

8065. You wish to direct attention to the Minority Report of your Committee on Beer Materials?—I do very respectfully urge you to consider my recommendations, which I think the members of the Commission have had before them.

8066. Are you still of opinion that there are some malt substitutes injurious to health?—I believe so.

8067. Do you believe that they are deleterious to health?—I believe some of them are deleterious to health.

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Some malt substitutes injurious to health.

8068. Some are deleterious and some are not?—Some are not.

8069. You believe that some glucoses are not deleterious?—I should think that some of the sugars are not deleterious.

8070. But glucose in particular you think so?—I think from the evidence that we had before the Committee the manufacture of glucose is questionable as to the materials used.

8071. With proper materials, do you consider it would be necessarily deleterious to health?—No, not with proper materials. I think it would be cheating the public, but certainly not injuring their health.

8072. Had the Minority Report of the Beer Materials Committee been acted upon, would that have made any difference in respect to the Manchester poisoning?—I think if that report had been acted upon it is quite possible the Manchester poisoning case might have been averted.

8073. In what respect do you think the contamination by arsenic would have been avoided if that report had been acted upon?—By a proper supervision of the materials of which beer is composed.

8074. With regard to the action of the Excise officials or the authorities at Somerset House, do you consider that that action has been a safeguard to the public

health?—A very good safeguard to the revenue, but a very poor safeguard to the public health.

8075. Has it been any safeguard at all to the consumer's interest?—I cannot say it has been, because they were of opinion in the evidence that was given before the Committee that there was nothing deleterious used in the manufacture of beer. Experience has proved the contrary.

8076. Do you consider a court of reference, such as is referred to on page 10 of your report of the Beer Materials Committee, should be speedily established?—I do. It was a recommendation of the Parliamentary Committee on the Adulteration of Food Products, and I quite endorse that recommendation. I think that a court of reference composed of competent experts and sound business men should be established for fixing the standards of purity and deciding other points arising under the Sale of Food and Drugs Act.

8077. You consider that guarantees from growers of barley or other produce are not desirable?—I think it would be perfectly ridiculous on the part of a farmer to give a guarantee about his barley. If I was a maltster I should not give any further guarantee than to say I had used the best fuel, and if I were a hop-grower I should say I had used all good materials in the drying of my hops. I should not say anything else.

8078. What have you to say on the opinions of chemical experts and others, some of whom were appointed on the Committee by the Manchester Central Brewers' Association?—Some of those gentlemen also gave evidence before the Beer Materials Committee, and they convinced the majority of that Committee that no ingredients harmful to health were used in brewing. Now, from this further investigation they seem to believe that almost every ingredient used in brewing is more or less poisonous. It seems to me to be this: that they can prove anything when they like, and they can prove nothing when they desire to do so. The effect upon farmers and others is that, as these continual scientific scares are proved mostly to be wrong, when there is any real sound, scientific discovery they are very slow to believe it. I think that is a very sad thing for us, and for the country generally.

8079. Did the chemical experts suggest it is impossible by analysis to ascertain of what materials beer is composed?—Most of them did, at any rate; one or two on the other side said they could discover any large adulteration, and they could also, they thought, discover adulteration even in small quantity.

8080. Did they think that substitutes used by brewers were harmless?—They did, and the majority of the Committee did.

8081. Have you read the report recently issued by the expert committee of the Manchester Central Brewers' Association?—I have read all that which refers to barley and hops and farming.

8082. Did that expert committee make any statement with reference to beer materials?—I suppose it did, but I have not taken any particular notice of that. I went mainly on what they said about the soils, the manures, and barley. I have the authority of Dr. Voelcker, the chemist of the Royal Agricultural Society, to say there are sundry soils which naturally contain arsenic. With regard to manures, I have never heard any charge brought against superphosphate until quite recently. With the permission of the Commission I should like to read a short extract from a letter I have received from Mr. Tom Brown, the managing director of the West Norfolk Farmers' Manure Company, in which he says that more than forty years ago, when they first began to use sulphuric acid for dissolving bones and coprolites, "boxes of soil were sprinkled with arsenious acid in various quantities, and vegetable seeds sown, in some cases immediately after the dressing of arsenic, in other cases a week or a month or three months after the arsenic was applied. When the seeds were sown immediately after the arsenic was applied, the plants perished, but when the seeds were sown a month or two afterwards the plants grew apparently with no hindrance. The conclusion arrived at was that the arsenic had taken an insoluble form not available to the plant. The plants that grew were removed and treated, some in a green state, others dry, and burnt in a hooded crucible, and in no case was any arsenic detected. Dr. Plowright, of Lynn, and Mr. Hamlet, now the superintendent of the New South Wales chemical laboratory, shared the labour of these experiments with me. I did not think at the time that they were of any public value. They were undertaken at the suggestion of the chairman of this company, and none of us thought them of sufficient scientific interest to publish them."

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8083. (*Sir William Hart-Dyke.*) What date is that?—That is about forty years ago.

8084. About 1861?—Yes; then he goes on to say, "It would be easy in this neighbourhood to point to a very large acreage where as much as 10cwt. per acre of superphosphate has been applied, to my knowledge, four if not five times during the last ten years. If therefore the arsenic and superphosphate could be absorbed by the potato crop, it would require a very small amount of labour to isolate the arsenic in the tubers grown in such soils. The 'Lancet' commissioner can end the matter in a few hours whenever he pleases by testing vegetable substances grown with superphosphate." It is a very common practice indeed in the Fens where potatoes are grown to apply as much as half a ton of superphosphate per acre.

8085. And sometimes more?—Sometimes one ton.

8086. (*Chairman.*) One ton to the acre?—One ton to the acre. The potatoes are actually on the manure. I have seen them taken up with portions of the manure adhering to them, and I have never heard of anybody's internal laboratory saying there was arsenic in them. With regard to superphosphate as applied to roots, nine-tenths of the superphosphates used in our county is used for the production of roots. I suppose the arsenic ought first of all to go into the turnip, then through the sheep, then into the barley, and then through certain malting and brewing processes; but I should have thought that the sheep would have been the first animal to take any bad effects from the arsenic. I never heard of it.

8087. Do you know if potatoes or turnips have been ever tested for arsenic?—I do not.

8088. Have you known cattle or sheep affected?—Not from eating malt culms or sproutings. This spring I had some lambs go wrong, ten of them dying, from eating the flower of some thousand-headed kale. I was very desirous of checking the disorder, and I had the greatest difficulty in getting malt culms. However, I got half a ton, and I have not lost a lamb since. The difficulty I experienced in getting these malt culms shows how very generally they are used, and how much they are prized by stock-owners and farmers. I have a letter here from Dr. Stutzer, the Professor of Agricultural Chemistry in the University of Konigsberg, and his conclusion is this, "From these figures it would appear that we have to deal with such very minute quantities that there cannot be any question whatever of poisoning the plants through arsenic, and of course there cannot be any question of poisoned malt and beer through the soil, even if it could be proved that plants are entirely insensible to the poisonous action of arsenic, which, however, as we mention above, is not the case." I believe he is a German chemist of very high authority.

Malt culms prized by stock owners.

8089. Do you think beer ought to come under the operation of the Food and Drugs Act of 1875?—I do. As I was chairman of the Adulteration Committee upon which the Food and Drugs Act was founded, I may say that we wished to bring beer into that Act, but we found we could not do so, as there was no legal definition of what was beer.

Advocates a definition of beer for purposes of F. and D. Acts.

8090. (*Sir William Hart-Dyke.*) As to whether it was food or drink?—No; what it was composed of. The report which I drew up was generally considered to be satisfactory, inasmuch as the public were assured that they were cheated and not poisoned. But it appears, in the case of beer, that they have been both lately.

8091. (*Chairman.*) Would you propose any official definition of beer?—I would. I would suggest the passing of the Bill which is now before Parliament, and which defines what beer should be. It is said not to be a "Pure Beer Bill." That is quite true, but it is a declaration and a definition of what beer should be, and I think it would be very disrespectful on the part of the promoters of that measure if they had attempted to legislate upon the question of arsenic, or adulteration in beer, when those questions were specially committed to this Commission. I think they were perfectly justified in not mission. I think they were perfectly justified in not

8092. You prepared the report of the Committee on which the Sale of Food and Drugs Act was founded?—

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I did, and I was also principally employed with the Local Government solicitors in drawing up that Act. We found it very difficult to define what adulteration should mean, but we said that the "nature, substance, and quality of the article" demanded by the customer should be given, and that I believe has been generally a successful definition of adulteration. I have also had very considerable experience in investigating sewage farming, for I was appointed as a Departmental Committee with Sir Robert Rawlinson, the Chief Inspector of the Local Government Board, to investigate all the systems of sewage in Great Britain and on the Continent. Anyone who knows anything about sewage knows perfectly well that the most filthy substances are used for the purpose of irrigation over the soil, and very frequently over the vegetables, and grass growing, but I never heard of any disaster or poisoning happening to stock eating that grass or from the milk produced.

8093. Do you consider the present Beer Bill or some such measure should be passed?—I respectfully entertain the hope that this Commission will report in favour of some such measure. I have had the opportunity of reading carefully through Mr. Stopes' evidence, and I entirely agree with all that I know in it, and I believe in a great many things he will say which I do not pretend to know.

8094. (*Sir William Hart-Dyke.*) You have had special experience not only as a farmer but as a barley grower?—I have.

8095. East Anglia is particularly favoured in that regard; the lightness of the soil is in favour of growing what is called a good sample of malting barley?—We consider we can grow the best barley in the world.

Object of Court of Reference to fix standards of purity for purposes of F. and D. Acts.

8096. You urge that had your Minority Report been acted upon this disaster at Manchester might have been averted. Would that have been through the action of this court of reference composed of competent experts and sound business men fixing standards of purity and deciding other points arising under the Sale of Food and Drugs Act? Do you mean the action of a body acting as a Government Department to deal with these matters, or do you mean a Court for the purpose of fixing standards of purity?—I fancy there should be in addition to the Excise authorities, much more strict supervision of the various articles that are being used in brewing.

8097. I had better read the clause. What you recommend is: "A court of reference composed of competent experts and sound business men, to be established for fixing standards of purity and deciding other points arising under the Food and Drugs Act." Was it in your mind when you drafted this that these competent experts should fix a standard of purity and that some Government Department or other body with statutory powers should enforce that standard?—I think so. But there ought also to be a more diligent supervision of the ingredients used in beer—I should have thought by the Medical Officer of Health or some other officer of the local authority as well.

8098. You think in the first place a standard of purity should be fixed, and then that any Government Department which had statutory powers, such as the Local Government Board or the Inland Revenue, should do their utmost to secure that standard of purity?—That is my idea, and this Committee of Standards of Purity would work entirely in conjunction with the Excise. There can be no doubt that the Excise are very useful, particularly for the purpose of protecting the revenue, and if their attention had been called to poisonous ingredients I have no doubt they would have discovered them. You must remember that previous to the year 1880 there were all sorts of ingredients discovered in beer, but suddenly they disappeared from the list of adulterations discovered by the Excise.

Beer Bill 1901.

8099. Then, when you urge that the Inland Revenue failed as regards this particular instance, you are yet of opinion that if the machinery under which they work were improved and fresh obligations imposed upon them it would be a great security?—I think it would, in conjunction with the local authority.

8100. Would you also suggest an amendment of the Food and Drugs Act if necessary?—I think if the Beer Bill were passed that would do all that I require. It would define what beer is and bring it under the purview of that Act.

8101. You think the Bill now before Parliament would indirectly prove an amendment of the Food and Drugs Act?—It would bring beer under the Act.

8102. You think the barley grower should have a free hand as regards any guarantee that might be demanded of him when his product goes into the market?—I think it would be absolutely ridiculous to ask a farmer who sold a clean sample of barley to guarantee it.

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8103. You think whatever guarantee may be given should be at a later stage in the manufacture of beer?—If there is to be a guarantee it should begin, not with the raw article, but with the manufacture of the article.

No knowledge of stock having been poisoned by malt culms.

8104. With regard to malt culms, as a sheep farmer you have from time to time used malt culms extensively?—Yes, for lambs and calves particularly, and for the purpose of adding a nice flavour to coarse feeding materials. They are very useful.

8105. If there were really any deleterious results would they not be more severely felt in young animals, like lambs and calves?—I should say so, certainly.

8106. A lamb three or four months old would feel more immediately the deleterious effects than an older animal?—I should say so. I have known lambs to eat too much of them, they were so extremely fond of them.

8107. I suppose you have read some of the evidence that has been given before this Commission, especially with regard to the finding of arsenic in malt dust and malt culms?—Yes.

8108. Have you had any practical experience as a maltster?—No.

Malt dust not used to feed stock.

8109. You are aware that evidence has been given in some cases of a great quantity of arsenic being found in malt dust, the dust which gradually collects in the process of malting in the kiln. This malt dust has never been used for feeding purposes?—Never, but we use it very extensively as a manure. I should think that all the arsenic comes from bad fuel. I know a good many maltsters in Norfolk, and I am sure they use nothing but anthracite coal.

8110. You think the best security would be greater care in the selection of fuel by the maltsters in the future?—I do not like to speak with any authority, but I should think that gas coke had better be prohibited altogether.

8111. From what you have heard?—Yes; from what I have heard, that is my opinion. I think gas coke is very injurious to the men making the malt.

Use of inverting sugar in beer should be declared.

8112. Are you in favour of restricting the use of invert sugar or glucose by brewers?—Not at all, only I think they should let us know they use it.

8113. You prefer the provision in the Bill now before Parliament, which would insure to the consumer a knowledge of what precisely he is drinking, to any attempt to restrict the use of these materials?—I do not say I should not like to do it, but I should certainly not advocate it.

8114. As an agriculturist of 60 years' standing, have you ever had the least suspicion that either through the indirect process of manuring or through the feeding of stock there is any reason to suppose that danger has accrued through the use of malt culms?—No. It is my deliberate opinion that, if there is any arsenic adhering to the malt, with thorough good screening and proper brushing the whole can be taken off.

8115. (*Sir William Church.*) You say that you are still of opinion that some substitutes are injurious to health, and certain glucoses give rise to deleterious effects: what is your opinion based upon?—Upon evidence that we had before the Committee.

8116. I am afraid I am not so conversant with that evidence as I ought to be. What was the evidence that weighed with you?—The evidence of Dr. Schidrowitz, in which he said, "There are strong grounds for stating that at the present time materials which are possibly of an injurious nature are still employed," and he instances sulphuric acid as largely employed in inverting sugar, and says the use of salicylic acid as a preservative is open to grave objections. Then there were some experiments performed upon cats, and the result of that was that certain glucoses had deleterious effects on the cats.

8117. Your opinion is only formed on what you have heard or read; you have never had yourself reason to think that ill effects followed?—I have drunk some exceedingly bad beer in my time, and I believe a good deal of that was made from substitutes. I never took any harm from drinking malt beer.

8118. By substitutes you mean made from starch or meal rather than malt?—Made from substitutes for malt.

8119. You are speaking of substitutes as distinct from sugar substitutes?—I had rather class it under all substitutes.

8120. It is rather a strong expression to say you are of opinion they are deleterious if you do not make a distinction between what may be called raw material and manufactured material?—I only give you my opinion. That opinion is based upon the evidence of scientific men, analysts, chemists, and others, given before that Committee.

8121. Did they say that if the substitutes were good of their own nature they were less wholesome?—They said they made it less nutritious certainly. They did not say they were poisonous, and I believe some of them did not think they were deleterious.

8122. You spoke of sulphuric acid being used: was not that rather because of an idea in the public mind that sulphuric acid was actually added to beer?—I should say not; not those who knew anything about it.

8123. The evidence which weighed with you was given with regard to sulphuric acid being used in the preparation of these sugars?—Yes.

8124. On what grounds did that gentleman state that sulphuric acid used in that way was likely to make the beer unwholesome?—He thought that some of it contained arsenic.

8125. He was aware it might contain arsenic. Did he say that if the arsenic was removed the materials made by sulphuric acid would be unwholesome?—I do not know that he was asked that, but I am sure he would have said so if he had been asked.

8126. You cannot tell what he might have said?—I gather from his evidence that he thought sulphuric acid might, and did contain arsenic.

8127. That everybody knows?—And that if that was employed in the inverted sugar it would be very dangerous.

8128. (*Chairman.*) Was that evidence about arsenic given before the recent scare?—Yes.

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8129. (*Sir William Church.*) With regard to the present Bill for amending the law relating to the manufacture and sale of beer, you regard that rather as a desirable Bill in the interests of the public, but you do not regard that as being a Bill for the safeguarding of every beer made with substitutes?—No, it is not a Pure Beer Bill.

8130. This report expresses your own views of what you think in the interests of the public beer should be, and you give them the opportunity of knowing which sort of beer they are drinking?—Yes.

8131. So that you do not regard this Bill at all as safeguarding the public from the possible contamination of beer made in other ways?—I do not. The Bill will carry out my desire which I have had for the last 25 years, that beer should come under any Act to prevent the adulteration of the food and drink of the people.

Beer Bill will not safeguard public from deleterious matters in beer.

8132. (*Mr. Cosmo Bonsor.*) Were you one of the Committee that drafted this Beer Bill? Who is responsible for the Bill?—I am not.

8133. Do you happen to know who the authors of it are?—I suppose Sir Cuthbert Quilter, and most likely Mr. Chaplin, and those members on the back of the Bill.

8134. You know that the Bill permits a certain addition of sugar after the beer is brewed?—Yes.

8135. Do you think that that should be allowed?—No.

8136. Then you do not approve of the Beer Bill?—I do not approve of Sub-section 1 of Clause 9; with that exception it has my entire approval.

Mr. Henry Stopes, called; and Examined.

8137. (*Chairman.*) You are a maltsters' architect and engineer, a member of the Council of the Central and Associated Chamber of Agriculture, a member of the Society of Engineers, and the Chairman of Judges of the Brewers' Exhibition?—Yes. I may say I have acted as Chairman of the latter body from the commencement of the Exhibition.

8138. You are also the author of "Malt and Malting," "Barley and the Beer Duty," and other works?—Yes.

8139. You were appointed in April last with Mr. Clare Sewell Read to represent the Central Chamber of Agriculture before this Royal Commission?—I was unanimously appointed with Mr. Read; there was no difference of opinion.

8140. You have had extensive experience and practice, and previously you had made careful study and observation abroad?—Yes, I have been practising in London for 21 years, and I have travelled somewhat extensively. I went through every country of interest from a beer standpoint in Asia, Africa, and America, and therefore I suppose I have had some extensive experience abroad. My chief study was in points now before the Commission, with respect to agriculture, malting, and brewing.

8141. I believe you invented and designed certain malt kilns?—Yes. The two-floor kiln was devised by me as the outcome of what I observed of drying on the Continent with kilns of similar construction, but differing in the methods of applying the heat, and such kilns have proved very effectual and useful in this country for the last 20 years.

8142. Will you describe that kiln to the Committee?—Practically the principle is that in the construction of a kiln I first make it effective in passing through the grain a sufficient volume of air to remove the moisture, a thing which is essential. Throughout the process of the removal of the moisture air is applied at such temperatures as will best effect the subtle, and I believe at present unknown changes occurring in the grain, which actually amount to the cooking of the grain throughout the process. By the adoption of two floors instead of one, one floor in this country having hitherto been the universal practice, I enabled the air which passed over one layer of malt, and which derived but a very small amount of moisture from such a layer, to go through a second layer of very green or wet malt under the best possible conditions to remove the moisture and give the necessary heat, and also to give a portion of the empyreumatic products of combustion.

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8143. Has the air in that case passed through the fire?—Yes, it is simply the products of combustion which, with the excess of air not used in the process of burning, has passed through the first layer of semi-dried, and ultimately completely dried grain, and then acts on the utterly wet grain, which is placed upon the upper floor.

8144. But you do not protect the malt from exposure to the fumes of the fire?—No, because it is absolutely essential and necessary that the products of combustion should come into contact with the malt. You cannot possibly make malt without such products of combustion coming into direct contact.

Fumes essential to flavour of malt.

8145. German malt is made without the air passing through the fire, but you say it is impossible. The thing you say is impossible is done in Germany?—Because in Germany they have a totally different system of brewing. If you adopt the English system of brewing, that is, the ordinary infusion system of mashing with the high temperature fermentation, which are the two main essentials of the English process of brewing, it is imperative that you have the products of combustion in your malt. If you adopt the low system of fermentation and the decoction system of mashing you are then indifferent to such products of combustion.

8146. We have had evidence before this Commission that hot air which had not passed through the fire gave malt that was fit for brewing in the English system?—I believe only one witness has given such evidence, and although he is a witness I know personally, and for whom I have the highest personal respect, I am absolutely certain he was mistaken. It is impossible to dry malt under the conditions he stated. When we can deal with a positive fact we can disregard opinion.

8147. You mean that in your opinion it is not possible?—Apart from my opinion, we must adhere to the facts. When you load into a kiln a quantity of green malt, which has just finished growing, and is ready for drying, you have in it a large volume of water, which water must be removed, and in order to remove it it is absolutely necessary to have a given volume of air passing through it capable of removing such moisture.

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8148. But that air may be hot air which has not passed through the fire?—That is another question. The point which I understood you were asking me upon was with regard to the evidence of Mr. Earp, who gave evidence of one of his kilns having become blocked up and thus prevented the admission of air, and yet he had made good malt. If you have a plate covering the kiln floor which does not admit any air at all you necessarily have a position in which you cannot dry owing to the want of admission of air.

8149. Then I understand that plenty of hot air through the malt is what is necessary?—No. It has been tried many times. Kilns have been constructed in this country with the view of drying as they do in Germany, where they use only hot air, but up to now no such kiln has ever produced malt which can brew satisfactorily. Therefore I hope I am justified in assuming that it is necessary to have the products of combustion as well as the hot air.

8150. In your opinion?—And as a matter of fact. It is an opinion which is not merely a matter of hearsay or of my own conjecture. It has been proved conclusively. I could tell you if you wished the names of places where kilns have been erected on the German principle where malt has been made, where the maltster who has made it has been unable to sell it, and where the brewer who has also attempted the principle has been unable to brew it. Consequently, I believe I am justified in asserting as a fact and not as an opinion that it is necessary to have the products of combustion in direct contact with the malt in order to ensure malt capable of being used.

8151. Is it the carbonic acid, or the carbonic oxide, or hydrocarbons from the fire that you consider to be necessary in air for properly drying malt?—I regret I have not the necessary chemical knowledge to answer that question as I wish. Of course, it is only a matter of opinion with me, as I have not the necessary knowledge. My opinion is an empirical one based only upon experience. It appears the combination of all three, plus some other thing which we at present know nothing about, is necessary. There are certain changes induced in the internal structure of the barley grain itself or in the starch and the other materials that constitute the barley grain which have never been fully investigated, which I cannot claim to understand, and upon which I greatly regret I cannot give fuller information; but the fact remains that you have to put the barley when in that state under such conditions to get the desired result. Why it is, I cannot tell you.

8152. You have designed and supervised the erection of the largest pneumatic malthouse in Britain?—Yes, and I believe it still remains the largest house. At the time of its erection it was certainly the largest pneumatic malthouse in this country.

8153. That is for spirits and not beer?—It was for a distiller's use. I mention that solely to show that I have some experience of the difference in the use of malts by distillers and the use of malts by brewers. That house is an exceedingly successful one.

8154. I believe that on behalf of British agriculture you have evidence which you think desirable to lay before us?—I wish to direct attention to the fact that arsenic is said to be present in hops, barley, and malt. I believe its presence in malt in very minute traces in almost every case has been proved, but I fail to see that sufficient evidence has yet been produced of the presence of arsenic in barley or in hops.

Risk of plants taking up arsenic from soil negligible.

8155. You say in your précis that some soils contain arsenic naturally; has that any effect?—I have been informed by chemists of very high standing in this country that it is a fact that certain soils which contain pyrites do contain arsenic, but of course that is simply a matter upon which I have received information, and of which I have no knowledge. But I have put myself into direct communication with a number of the largest manufacturers of artificial manures in the country, and they are entirely at one in the information they gave me, that in the superphosphates and other manures used by barley growers or hop growers, the proportion of arsenic—assuming that even arsenical sulphuric acid has been used—is exceedingly small, and that that again is reduced by the fact that assuming arsenic to be added to the soil, a very small portion, if any, is picked up by the plant. They are all of the opinion that the amount contained, especially in the seed berry of the barley plant, is utterly negligible.

8156. What have you to say as to the fuel used by maltsters, or for drying hops?—May I say before answering that question that I entirely confirm what Mr. Read said. I heard his evidence. He gave the opinions of two or three important people, and I have ample information to confirm them very fully. With regard to fuel, the amount of arsenic in coal, even if we admit there is arsenic in coal, is exceedingly small. With many oven cokes there is positively none, or it is so exceedingly minute as to be absolutely negligible. I believe charcoal has never been accused of containing arsenic in any form. The only fuel which is under suspicion is gas coke. With reference to that, I may say that, as the outcome of my experience, whenever I have found a maltster employing gas coke I have advised him to discontinue it, for the sole reason that it is an undesirable material to have owing to the effect it has upon the men. The men cannot work in the presence of the fumes arising from gas coke with the same comfort and the same pleasure that they can when a purer material is used.

Gas coke injurious to malting hands.

8157. Would you consider common charcoal to be suitable?—When a man goes to the expense of using charcoal, I certainly consider he ought to be allowed to continue its use without any suggestion of impropriety. There are many good hop growers in Kent who I believe go to undue cost in providing charcoal to dry hops, believing that it is proper fuel, and as a consequence I should think it would be very undesirable to stop such men using it. I know of my own knowledge that a number of men employed in this business make a respectable living in burning the charcoal, and that the good hop growers who use this charcoal do so with the knowledge that it is really more costly than the best anthracite coal. They use it therefore in order to produce the best possible result. They want to grow hops thoroughly well.

Sulphuring hops.

8158. What have you to say with regard to the use of sulphur by hop growers or maltsters?—It has been said by one or two witnesses that sulphur is used very largely by hop growers, and that some maltsters use it. I believe that the number of maltsters who employ sulphur in that form, burning it upon the fire with the drying material, is exceedingly limited, and I believe as a matter of fact that the hop growers who use sulphur in that way do so solely with the view to pleasing their best customers—the brewers. The brewers like to have hops presentable to the eye; they like to have them nice in appearance, and the sulphur gives a better green, a nicer, brighter, and more living colour to hops than the hops without the sulphur would have. Consequently it is entirely in deference to the wishes of the brewers that the exceedingly small amounts of sulphur so burned are used by hop growers. That such a combustion of sulphur could add an amount of arsenic in the slightest degree harmful is to my mind simply ridiculous.

Brushing should remove all arsenic from malt.

8159. In your opinion does any arsenic remain when malt has been thoroughly brushed?—I should say that if an efficient brushing apparatus be employed, unless it can be proved that the arsenic penetrates the skin of the barley grain, it would absolutely remove the whole of the arsenic. Any effective system of brushing would do that. With reference to that matter, I may say that fifteen years ago I put into Messrs. Barclay's experimental brewery an exceedingly severe form of brushing arrangement known as a smutter or wheat scalper, and that machine is running to-day, and I am authorised to say running with great satisfaction, cleaning the malt absolutely efficiently and thoroughly. I am perfectly certain that with the use of that machine, no matter what quantity of arsenic may have been deposited on the skin of the malt prior to its insertion in the machine, it would effectually and efficiently remove it. That is a thing capable of proof.

8160. You say in your *précis* that there are two systems of making malt?—I hope I may be permitted to say what I know with regard to the barley. I am chairman of the barley judges of the Brewers' Exhibition.

8161. That is scarcely a subject for this Commission. This Commission has not to decide with regard to different barleys?—But the farmers feel very grievously that a great deal has been said here with regard to the presence of arsenic in barley, which is extremely detrimental to their interest.

8162. (*Mr. Cosmo Bonsor.*) By whom?—A great deal of evidence has been given before this Commission.

8163. (*Chairman.*) Very little evidence about arsenic in barley has been given before this Commission.

There has been evidence of arsenic in malt, but the evidence about barley has rather pointed to its not containing arsenic?—If it be accepted that that is the view of the Commission that barley does not contain arsenic, I will gladly pass over the point; but I wish there should be no misunderstanding. There has been, as far as I can remember, references made that second-rate British barleys could not be used, and that sugar and foreign barleys have to be used in its place, or if sugar be prohibited, then a much larger quantity of foreign barley would be used.

8164. (*Sir William Hart-Dyke.*) That is apart altogether from the question of arsenic in beer or arsenic reaching the malt through the fumes of the fuel?—I was merely wishing to combat the suggestion that arsenic could be traced back to the barley. If I may take it that is dismissed, I am only too glad.

8165. (*Chairman.*) In your view arsenic is not found in barley?—I wish to confirm that absolutely. I say it is ridiculous. With reference to arsenic being liable to be present in the different systems of malting, I say there is no difference. So far as the indication of arsenic is concerned, it is just as liable to be introduced by any system of pneumatic malting as by the old-fashioned English system.

8166. You say in your *précis* that the two systems of making malt, by the old-fashioned open floor system, and the several types of pneumatic houses are alike unable to add arsenic to malt?—It is not able to do so—there is no liability.

8167. Do you contest the evidence that has been given that malt is liable to become coated with arsenic through the use of fuel, the fumes of which contain arsenic?—Up to the present the system of drying has been the same for both systems of malting, and the point I wish to make is that there is no difference whatever system of malting be adopted. It is purely a question as to how the fuel is used, and, still more important, as to the character of the fuel employed.

8168. (*Mr. Cosmo Bonsor.*) The system of malting you are alluding to on the floor is the system of germinating the corn, and whether that is on an open floor or in what is called a pneumatic drum, it is the same thing?—Yes.

8169. The question of the kiln comes later?—Yes.

8170. (*Chairman.*) I should consider making the malt to include, first, the germination, and, lastly, the drying. But your remark is limited to the first process, that no arsenic gets into the malt in the germination process?—Yes. In my *précis* I say that up to the present the modes of drying are the same for both apparatus.

8171. You go on to say in your *précis* that "air heated only cannot make good malt, as the products of combustion must be in direct contact with the malt when wet. The different flavours of black, brown, and numerous varieties of malt, are alone attained by attention to this law?—That is so.

8172. But in the process of making black malt, is not the final process, giving the distinct flavour, one in which the malt is heated to a high temperature in a cylinder, outside the products of combustion altogether?—That is so, but there again properly made black malt should have been subject to the influence of fuel on an ordinary kiln prior to being placed in the cylinder, because genuine black malt ought to be first of all germinated and dried in the ordinary course prior to submission to the higher heat of the cylinder which will caramelise it.

8173. Whenever malt is used by a brewer, do you think it necessary or a good thing to give it a final brushing prior to screening?—I think it is desirable that maltsters should clean malt efficiently prior to delivering it to a brewery.

8174. A primary brushing?—Yes.

8175. And the brewers should give it secondary brushing?—Yes, wherever a brewer has power it is certainly to his advantage to give it a complete brushing prior to use.

8176. You tell us that the Chambers of Agriculture are quite clear that the liability, should the presence of arsenic be detected in beer, ought, under no circumstances, to be carried back to the grower of hops and barley?—That is so; it is exceedingly unfair to throw the onus and responsibility upon the grower either of barley or of hops, and I believe not only do the Chambers of Agriculture agree in that view, but almost every farmer and hop grower throughout the country.

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8177. But you would agree that the responsibility of arsenic in malt should fall upon our makers of malt?—If they are contributory to the arsenic being present, most certainly.

8178. You have told us that the arsenic does not get into the malt from the barley?—Quite so.

Maltsters should not be asked to guarantee malt as regards arsenic

8179. Therefore it can only get in by the process of making the malt; and you think the responsibility of no arsenic in the malt should be on the maltster?—In that case I do not think the maltster should be asked for a guarantee, because if a brewer wishes to buy malt from a maltster, especially with his existing knowledge, he has the power to test such malt. He has no necessity to shield himself from the use of such malt by getting a guarantee from the maltster.

8180. But should not the maltster himself make sure that he gives his malt without arsenic?—In the ordinary course of trading he would do so. Unless he was in a position to know his malt was pure he would not offer it to a brewer. My point is that it is not necessary or desirable that a brewer should insist on getting a guarantee from the maltster.

8181. You mean he must obtain arsenic-free malt from the maltster?—Certainly, and he has the power to secure that.

8182. And that a maltster selling malt to a brewer would imply that it was arsenic-free?—Certainly.

8183. But you would not have him give any guarantee in writing?—No.

8184. You would let it be understood that the maltster gives it arsenic-free, but you would not ask him to give a written guarantee?—Precisely, because the brewer has the power to determine that the malt is arsenic-free prior to purchase.

8185. If the maltster gives him malt containing arsenic, the brewer can find out?—Absolutely.

8186. (*Mr. Cosmo Bonsor.*) Not prior to purchase?—Certainly.

8187. (*Chairman.*) Do not you think the maltster himself ought to be held responsible, and not leave it solely to the brewer to find out his fault?—I think that the brewer in the ordinary course of business has ample opportunity to ascertain for himself that the malt he is about to purchase is arsenic-free.

8188. Then you correct the answer you previously gave, and you now say the maltster gives his malt without any guarantee, and tells the brewer, "Remember, I do not guarantee this malt arsenic-free"?—I do not say that. What I think is that he should not be asked to guarantee.

8189. That is to say, the maltster must give it on the condition, "I do not know whether there is arsenic in it or not. I give it to you as I have made it"?—I do not go so far as that.

8190. You would not let it be put in writing, but you would have it understood that was arsenic-free?—The maltster ought to know it was arsenic-free, and he should take every care that it was so.

8191. If he knows it, should he not say so to the brewer?—Certainly, but at the same time I do not think the brewer should go back on the maltster and insist on having a guarantee before purchase, because if anything arises he has the maltster to fall back upon.

Brewer should take responsibility of arsenic in malt.

8192. However much arsenic there is in the malt, the brewer should understand that the maltster washes his hands of it?—Certainly; he should buy the malt without arsenic. If the maltster does not know his business, and supplies malt with arsenic in it, the brewer, especially after recent occurrences, should be quite sufficiently up in his business to protect himself. What I object to, and what the farmers object to, is that the guarantee should be asked in the form that a number of witnesses appearing before this Commission have demanded, that there should be power to the brewer to fall back on the maltster with his guarantee.

8193. Let us leave the farmer out of it?—Leave both out of it.

8194. But the man who can put arsenic into the malt in the making of it cannot be kept out of it, and it is the first time we have heard it proposed by any responsible person that any kind of food business should be

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conducted on the principle that, "I sell you something which may or may not contain arsenic, which you are to find out—I do not know, and I do not care whether it contains arsenic." That is what I understand you to make the maltster's position?—Put that way, yes, but if I may be permitted—the point may be a very fine one—what I wish to do is this. I stand up in the interests of the maltsters, and I say that they should not tie their hands behind their backs and give guarantees which may some day fall very heavily upon them, because they do not have the final disposition of this malt. If in the course of manufacture, the brewer employs any material which may contain arsenic, and then tries to fall back on the maltster, that guarantee may prove a very awkward thing.

8195. My question did not relate to that, but solely to the malt supplied to the brewer, and your answer is that the maltster gives it to the brewer, and ought not to be asked by the brewer whether it is arsenic-free or not?—No, the brewer should ask, and the brewer should compel the maltster to know, but he should not ask for a guarantee that could exculpate him completely. That is the point.

8196. (*Sir William Church.*) You confuse two things. You are saying that the brewer should not be exculpated if arsenic is in his beer by having a guarantee from the maltster?—Yes.

8197. No one suggests that. He would have to show that the particular malt was in default, and that his other ingredients were free from arsenic. But why should the maltster be excused from selling a pure article any more than the person selling other beer ingredients?—If it be put that way, I think as practical men that the brewers have the power to protect themselves prior to purchase. It is so simple a matter to test malt for arsenic, and therefore the brewer can protect himself.

8198. (*Mr. Cosmo Bonsor.*) You have been at Mark Lane?—Yes.

8199. And you have seen brewers buy malt there by the samples? How can they test it—by their mouth or eye, or how are they to know that the samples contain arsenic?—Many brewers have now discontinued going to Mark Lane to buy malts.

8200. That is not an answer. I am asking you a question. You know that on Monday brewers go to Mark Lane, and do buy malt. How can they tell when they get a small bag of malt that that malt contains arsenic?—It might interfere with the dealing between maltster and brewer, and hereafter I believe no brewer will go to Mark Lane and buy by samples without investigation unless he is protected by a guarantee.

8201. (*Chairman.*) He will find out if it is not correct, but he will naturally want a guarantee from the maltster that it is free from arsenic?—The maltster can guarantee that he has used the best fuel he can employ, and I believe that ought to be the extent of his guarantee.

8202. The maltster can guarantee that he has himself tested his own malt?—Certainly.

8203. And would you disapprove of him testing it himself, and guaranteeing that it is free to the brewer?—I should say every maltster should test for himself, but should hesitate to give the guarantee.

8204. Should he tell the brewer he has tested himself, and believes it to be free from arsenic?—In the ordinary course of business if he were offering a sample of malt he would tell the brewer he knew it was arsenic-free, and I believe the transaction could stop there.

8205. (*Sir William Hart-Dyke.*) With regard to this question of fuel, I believe you urge that the quantity of arsenic in any coal, charcoal, or other fuel, is small. You are not a practical chemist, are you?—No.

8206. You do not test for yourself?—No.

8207. Where do you get this information?—From a variety of sources.

8208. What kind of sources?—Actual analyses by competent men.

8209. You say in your précis that no correct figures have been given in evidence before this Commission with regard to these matters?—As to the proportion of arsenic liable to be present in beer through the use of malt.

8210. Have you any evidence to offer us which would combat what we heard? It is an important statement to make?—It is.

8211. Have you any evidence you could produce before this Commission?—I would direct attention to one paragraph on page 7 of my précis, in which I say, "The assumed quantity of beer made in 1900, calculated at the official standard, was 36,578,000 barrels. But the actual quantity of beer or "bulk barrels" was 39,473,000 barrels."

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8212. That has nothing on earth to do with the question as to whether arsenic is in coke or other fuel. This is a two-fold declaration; in the first place, that very little arsenic is ever found in any variety of fuel; and further that the evidence which has been given is not correct. You say, "It is the same with fuel. The quantity of arsenic in any coal, coke, charcoal, or other fuel is small. No correct figures have yet been given in evidence before the Commission of the quantities of fuel used, and all statements as to amount of malt dried and quantities of malt brewed require correction." That is rather a strong statement if you have absolutely no evidence whatever to bring forward in support of it. Are you aware, for instance, that the Professor of Chemistry in Liverpool, Mr. Campbell Brown, has given evidence of having tested many varieties of fuel, and that in anthracite he has discovered as much as half a grain of arsenic per lb.? That evidence has been given before us, and there is other evidence of the same kind equally strong?—It is exactly that which I wish to answer. I cannot tell you of my own knowledge, as I have not examined the coal, but I have had submitted to me a large number of analyses by competent chemists wherein they have found no such amounts as you mention. In addition to that, in order to confirm what I there say, I wish to draw attention to the fact that the amount of malt dried by fuel has not been yet correctly stated, because there are many instances where maltsters are drying up to 60 quarters per ton of fuel. Ergo, if there be a small quantity of arsenic in the coal to start with, and if that coal be used so efficiently that it dries three times the quantity of malt assumed, certainly there must be a smaller quantity of arsenic carried through to the final product, the beer. I go further, and I say the amount of arsenic capable of being communicated to the beer by such means has not been correctly stated, for the simple reason that you have no statement yet before you which shows correctly and properly the amount of material used by brewers.

No arsenic in malt dried with anthracite.

8213. I would ask you whether you are not of opinion that as regards malting, if the evidence shows that the only danger arises from the fumes of fuel, great care in regard to the choice of fuel is necessary, whether coke, anthracite, or any other?—That is the statement of one class of fuel which has not been confirmed. It is entirely beyond anything known by any other analysts. We know as a fact that there is a very large quantity of anthracite coal, used through the whole of the eastern and southern counties, and that the malts dried by those fuels have been subjected to the severest tests, and have passed through them without showing the presence of arsenic. Therefore it is fair to assume that that must have been exceptional coal, and as a matter of fact I have no hesitation in saying it is a coal used by no competent maltster.

8214. (*Sir William Church.*) You are leaving out of consideration another point on which we have a good deal of evidence, and that is, that the malt you allude to has been well screened and brushed?—Not all—I know that of my own knowledge.

8215. But you do not know of your own knowledge, and you can never say that the London and southern brewers use their malt unbrushed and unscreened?—A large number of the southern brewers do use their malt unbrushed, but not unscreened.

8216. Do you mean that they properly screen it?—They screen it to the extent of removing the culms. Malt when it is dried ready for use undergoes one or two rough screenings by the maltster.

8217. I will not go into that. You spoke as if the absence of arsenic from the southern malt must necessarily be due to the absence of arsenic in the fuel used in drying it, but we have a great deal of evidence to show that careful screening, even without polishing or brushing, does a great deal in removing the arsenic which does get upon malt in the process of kilning?—Yes.

8218. I only wished to point out to you that your inferences are incorrect, because you leave out, in assuming it is all due to the purity of the coal, the effect of brushing and screening?—Not so. I believe

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that the brewers of Manchester have been quite as careful to get malt screened in the ordinary sense as any brewer in London or the southern counties. No maltster would dream of selling malt, and using it unless it had been efficiently screened. But that they brush it is another matter.

8219. (*Chairman.*) Do you know that much of the malt dust is found to contain a great deal of arsenic?—Yes, so it has been stated.

8220. (*Sir William Hart-Dyke.*) As much as two grains of arsenic per lb. of malt dust has been proved. You referred to one analyst just now; are you aware that no less than four analysts before this Commission have given conclusive evidence of finding arsenic in fuel? It is chiefly gas coke, but also anthracite, and all kinds of fuel used in the malting. The evidence is very conclusive. It is not as you suggest by one, but by four analysts, very high in their profession?—I do not wish to dispute that, except I do say—and I hope I may be permitted to repeat it—that the quantity of arsenic communicable to the malt is less than has been stated to you, and the malt itself is in such a position that it does not carry through the amount stated.

8221. That is no answer to my question. I am examining you upon a statement of yours in evidence as to the quantity of arsenic found in fuel. However, I will not pursue the point any further. I suppose you are of opinion that there are two processes by which with proper care and attention, security for the public may be absolutely provided, a process of cleaning and screening, and very careful attention to the use of fuel?—Quite so.

8222. Would you support that?—Absolutely.

8223. Many witnesses have come to that conclusion, that proper care must be taken in every case?—Undoubtedly, and if a man exercises proper care and caution in buying his coal and cleansing his malt efficiently, I should imagine there is no possibility of arsenical contamination.

8224. Are you aware that one of the largest brewers in Ireland uses malt only?—The largest brewer of all uses nothing but malt, and the next largest uses an exceedingly small quantity of sugar, but I am sorry to say it is used almost exclusively in the pernicious system of priming.

8225. Have you ever attempted to make any estimate in a bad barley growing season in this country, a wet season, for instance, by which you can tell the amount of English and foreign barley respectively the large firms of brewers in this country would use?—I have never know a season in which there has not been a sufficient supply for the largest brewers who pay a good price for the best barleys grown in this country.

8226. Even in a wet season?—The worst season. I have known every season since 1866. I have had to come into direct contact and judge the barleys of the season in a way which I suppose is not quite common, apart from Mr. Read, who has been good enough to act as one of the judges of the malting barleys at the Brewers' Exhibition. I have acted as chairman of that body for nearly 20 years. It has been my special and direct business to inquire most carefully into the actual quantity of the barleys grown season after season, and officially I state emphatically that I have not known any season in the whole of my experience when there has not been grown in this country a good quantity of barley suitable for the best uses of the best brewers. I believe Mr. Read will agree with me.

8227. Then in a bad season you think there is no excuse for any brewer to go to foreign barley to get a good barley?—That is another question. If there is not sufficient, and if it is necessary to import barleys because we have not grown enough, that would be only an ordinary business course. What I complain of is the very large and undue recourse to substitutes for barley made by brewers. They fly to foreign corn not when necessary, but solely with the view to depreciate the price of English grain, which is a totally different matter.

8228. (*Professor Thorpe.*) Assuming that malt substitutes, glucose and invert, continue to be used, would you extend the same principle that you laid down in the case of the maltster to the maker of those things—would you allow him to sell his product without any guarantee of its purity?—No, because he is conducting a purely chemical process which requires high training as a chemist; he is employing in the necessary process of his manufacture exceedingly dangerous and doubtful materials, and therefore he is on a totally different plane.

8229. How is he employing exceedingly dangerous and doubtful materials?—I have never heard of invert or glucose being prepared without the use of sulphuric acid, muriatic acid, or other acids. It is one of the simplest and best known things, as I need not say to an experienced chemist like yourself, that these things are more or less dangerous or doubtful.

8230. How are they dangerous or doubtful?—It has been known for a very long period now that it is extremely easy for arsenic to get into their manufacture.

8231. Now when it is proved to you that arsenic is equally easy to get into fuel, what in principle is the difference between one class of manufacture and the other?—There is no difference in principle. If I were a maker of glucose or invert I should say, "Buy my stuff as it stands and test it on its merits; I give no guarantee."

Does not demand that glucose makers should guarantee purity of their products.

8232. That is exactly the answer I desired you in the first instance to make. You would put the manufacturer of invert and glucose in precisely the same position in respect to the brewer that you put the maltster?—Yes, if they like to take that line. On the other hand, if in order to curry favour and sell their material they are prepared to give a guarantee, let them take the onus of giving that guarantee.

8233. You make that statement to us deliberately in view of the fact that the greater portion of this trouble has arisen through the manufacturers of these materials accidentally putting arsenic into them?—I do not admit it to be an accident.

8234. In view of these circumstances you nevertheless say if you were a manufacturer of invert or glucose you would recognise no obligation on you to furnish such certificates?—And I should think Bostock's are exceedingly comfortable in their minds that they gave no guarantee.

8235. If you were now in the position of a manufacturer would you still say there is no obligation on you to furnish that certificate?—If I were a manufacturer I should want to get out of giving the guarantee.

More English barley suitable for brewing than formerly.

8236. (*Sir William Church.*) I should like to ask a question or two with regard to the suitability of English barley. I think you just now said there was no year in which there was not a sufficiency of good English barley produced for brewing purposes if the proper price was given for it?—Yes.

8237. You have rather changed your opinion, have not you, of late years as regards the suitability of English barley for brewing purposes?—What would you call the "late years"?

8238. The last ten or twelve years?—I have been for nearly 20 years urging upon the British farmers the desirability of improving their methods of growth and adapting the material they produce to brewers' needs. Probably 12 or 15 years ago there was not so large a quantity of good barley grown as recently. If you are referring to writings of mine 15 years since you might perhaps legitimately say that I have changed my opinion lately.

8239. In what way have the farmers improved their growths of barley?—In every way. They have given much more attention to the preparation of the soil; have been much more attentive to the quality of the manure; the quantities and the modes of adding the manure to the soil. They have been much more careful in getting the seed sown at an earlier date. Many of them have been urged to sow even winter barley. They have been extremely careful, the majority of them commendably so, to get the best seed possible; instead of sowing tail-corn they have employed expensive barley of a very high class, and have paid more attention to the period of cutting.

8240. What is the result of all that?—That we get a very large quantity of superfine barley which cannot be surpassed and is not equalled by any barleys grown abroad.

8241. In what way is the barley different now from what it was then?—Then they did absolutely the opposite to what I now advise.

8242. What is the chemical condition of the grain which makes it better now than it was before?—I am not prepared to give a chemical opinion as I do not claim to be a chemist, but I am told by chemists that there is the right relation of the nitrogenous and albu

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mineral matters which enables the grain now grown to produce a malt entirely satisfactory to the brewer.

8243. (*Sir William Hart Dyke.*) Will it keep its colour after 24 hours of rain when it is cut? I have been connected with barley growing since I was ten years old as my father was before me, and should know something about barley, and one of the difficulties is to preserve the colour?—If you deal with a man who insists on having a white barley it will not, but if you are dealing with a man who likes to have a mellow and golden barley it will.

8244. Is it a question of climate?—No, it is not.

8245. As a large barley grower, and as I said connected with barley-growing ever since I was a youth, and having carefully watched its growth and studied it, I therefore ask you that practical question. Are the conditions you are describing such as to produce a good sample of barley after 16 or 18 hours rain?—Certainly it will, in a much better form. In the sale of barleys now, by great improvements in manure and If a man insists on having barley which is white, necessarily you cannot get it after 24 hours rain, especially if the barley has been laid or lodged.

8246. (*Mr. Cosmo Bonsor.*) Or grown?—It will not grow in 24 hours. If, on the other hand, you have the barley standing on proper straw, able to resist the influences of 24 hours rain, which you do not get in Kent, but which good Norfolk men know, it will stand 24 hours rain, and I have known barley growers get high prices for barley that had had 24 hours rain upon it.

8247. (*Chairman.*) Before being cut?—Yes, just prior to the time of cutting, when the barley is absolutely ripe and fit for the scythe. If there comes a period of 24 hours rain, and especially if the rain be heavy so as to beat the barley into the ground, it discolours it, spoils its appearance, and damages it very seriously.

8248. But it does not injure its quality except in appearance?—It injures its quality in this way, that if it is allowed to lie in the ground and get discoloured and sprout, but otherwise it does not. You can make absolutely as good beer with barley slightly stained with 24 hours rain as from the best barley grown in Kent. Of course, it is preferable not to have it stained if possible. Now, as the outcome of improved cultivation it is possible for barley to resist undue periods of wet in a better way than it did before.

8249. (*Sir William Church.*) I may take it that you would no longer write, as I think I am correct in believing you did some 12 or 14 year ago, that some proportion of foreign barley in the production of light beers was a practical institution, and that probably the fact of interference with the use of nitrogenous substitutes would be to increase the proportion of foreign barley. You stated that to another Commission?—Yes.

8250. Now, you think the agriculturist has so improved his agriculture that, not withstanding a cold or wet season, he would still be able to produce malt for a light beer?—I do not think I should go so far as that. I do say unhesitatingly that the amount of barley grown under normal conditions is much larger, but if the condition of the season be adverse I fail to see that there would be the power to produce such barley. If the season was so bad that no barley grew at all it would be ridiculous to contend that the farmer could produce it.

8251. I may take it at all events that you think our barleys now, by great improvements in manure and other ways, are so improved that ordinary English malt does not contain nitrogenous constituents in forms that render fermentation, attenuation, and the final condition of beer unsuitable and defective?—That is so.

8252. You think we have made really so great an improvement in agriculture in these twelve or fourteen years that we have now got to a certain extent a non-nitrogenous barley?—I do not think so. I believe I am in the position to prove it as a fact. I say unhesitatingly, it is so.

8253. If we have, do you not think that we have greatly lowered the value of our barleys as feeding stuffs?—I know nothing of the value of barley as feeding staffs. We have not lowered its value to the brewer, but the brewer has lowered the value to the farmer.

8254. You do not wish to give me an opinion. Most grains, as far as general feeding purposes are concerned, are valuable for the amount of nitrogenous matter in them?—I have no experience of the feeding value of barleys. My whole attention has been confined to the brewing value. The brewer has taught the farmer that he requires barley with less nitrogenous matter, and the farmer has adapted his processes to the brewers' need, and produces barley which is less nitrogenous and more acceptable to the brewer, and I hope every brewer in this country will confirm what I say.

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8255. I should like to know what you mean by a phrase in your *précis*. You talk about the "vital properties of malt." I do not in the least understand what that means?—It means that you must use malt to make beer, and that you cannot make beer without malt. There is some vital principle in malt which is not distinguishable by the chemist, which makes it imperative that the brewers should use some malt. I may use the wrong word very probably, but what I mean to say is that if you wish to brew beer you must employ some malt. I would argue further, and say that you cannot brew true beer if you employ a substitute for malt.

8256. (*Mr. Cosmo Bonsor.*) Not necessarily barley malt?—Yes, I have never heard of a single gallon of beer which does not contain some barley malt.

8257. (*Sir William Church.*) That is a statement of yours?—It is a fact.

8258. Can you give me an idea of what this vital principle is?—No, and no one else can. It is a matter simply provable; produce beer without barley malt, brew me a gallon of beer without any malt or any combination of malt.

8259. There are thousands of gallons of beer produced without any barley at all. It is not the same kind of beer, but beer all the same?—I am speaking of English beer as we know it.

8260. (*Professor Thorpe.*) This vital principle is not an entity, is it? Is it some quality which is capable of having material value attached to it, or what is this vital principle?—The value attached to it is that that alone enables you to produce beer. I cannot tell you what entity it has. No chemist has ever defined it. But there is a subtle something in barley malt which renders it imperative upon every brewer in Great Britain, if he attempts to brew beer, to use a proportion of malt. I have never heard of a single brewer in this country, with all my rich experience of brewers, attempt to brew beer without malt. I argue from that, that if it be necessary to use some malt, the more you displace that essential the further you drift from the true science of brewing, and the fluid you produce is not beer, and ought not to be so named.

8261. Your statement simply amounts to this, that malt is necessary to the manufacture of beer?—Yes.

8262. And you associate that with some transcendental principle or quality which is not material in the grain?—That is so. Here you have a large body of men with great capital, who are spending a large amount of intelligence in trying to produce beer by every process under the sun, and up to the present they have never succeeded in making beer without malt. Therefore, I say there is a something in malt which is not in anything else, and as a consequence beer ought to be defined as containing that to the maximum extent, and that everything else is made from substitutes which does not contain this essential essence is not fit to be called "beer," and ought not to be permitted to be called "beer."

8263. (*Mr. Cosmo Bonsor.*) May they be called ales and stout?—No, I think ale and stout with beer should be kept actually to the malt. It might be called aline, beerine, or stoutine, after the style of margarine.

Use of malt substitutes in beer should be declared.

8264. (*Chairman.*) You say that malt is necessary, but would you admit proportions of glucose and other substances?—I consider that when the public asks for beer it ought to have the product of malt only, without the addition of glucose, sugar, or any other substitute in any form, and that if all these things be added, there ought to be an intimation given to the consumer that it is so, and there ought to be a declaration made that a substitute has been employed, and it is not the genuine product of barley malt. There should be no hesitation or paltering or beating about the bush. That is a plain simple point that ought to be taken into account.

8265. (*Sir William Church.*) In the *précis* of your evidence in connection with this vital principle of malt (which you have not made any clearer to me than before) you go on to say that beer substitutes do not possess that vital principle, and, therefore, "recourse has necessarily been made to large quantities of powerful

antiseptics as preservatives in beer." To what do you allude to there?—I am very glad to have the privilege of answering that question, because I take it that that is really the chief point, if there be any value in anything I have said to you, which may be suggestive to you on that subject. In consequence of the poverty of the materials used by brewers, they now employ preservatives of many types, chiefly limes or sulphurs. Bi-sulphite of lime is the one more generally used. Salicylic acid is very largely used, and a number of very powerful antiseptics and preservatives are necessarily used.

8266. Do you mean by very powerful, "very powerful as antiseptic" or in other ways?—As antiseptics.

8267. Therefore it makes very little difference whether you use a very powerful antiseptic in very small quantity or a less powerful one in larger quantities so far as preserving your beer goes?—If you use sound good malt from good sound barley you have no need for preservatives.

8268. We have got beyond the malt. You have mentioned bi-sulphite of lime and salicylic acid; was there any other preservative present to your mind?—I mention a number, and there are many more—salicylic acid, borax, phylax, K.M.S., sulphites, bi-sulphites—they have been all referred to in previous evidence, and they are all used. In my opinion they are all dangerous, and the fact that they have been used has probably led to a number of dangers to the public health. It is harmful to me to have to swallow these things in the beer, and I should say it is harmful to other people. I feel them, and as I am a man of somewhat strong physique, I maintain that weaker organisms would feel them more keenly.

8269. Can you tell when you have drunk a gallon of beer which contains borax, or drink another gallon which contains salicylic acid, or another gallon which contains bi-sulphite of lime, which you have had?—I should feel very much ashamed of myself if I could not get to that point long before I drank a gallon. If there is bi-sulphite of lime added to beer I can tell you before I drink it by the mere smell, especially if it is added in the dangerous quantities it now is. It is the practice that every barrel that goes out from almost every brewery very nearly a pint is added, and sometimes more, of powerful bi-sulphite of lime.

8270. I find you have entirely changed your opinion also on the matter of antiseptics from what you held at the time you held out views about English barley, because at that time you thought that in adding such preservative agents first were necessary to enable the brewer to use English barley and suit the increasing fastidiousness of the public palate was only the greater advance of scientific knowledge. You did not at that time think they were the least injurious to health?—But since I have learned they are. You are referring to a period of fifteen years ago, and in that time I have heard of a great deal of harm arising.

8271. What evidence have you of any harm having arisen from any of these preservatives in beer?—You have the evidence that a large number of people have died and suffered in Manchester and elsewhere in a way not fully accounted for by arsenic alone.

8272. In what way is that not accounted for by arsenic alone?—I gather that from the reports I have read. Not being a doctor, I am not in a position to tell you in the language I should wish to use.

8273. But you have gathered an entirely erroneous conclusion from what you have read. You have not read carefully enough, or else you would have seen that the only question was the possibility of its being due to alcohol and the possibility of its being due to arsenic?—I cannot put my hand on the name for the moment, but I read a very important article by a doctor in the "Lancet" last week which appeared to confirm my own view. In the evidence which I have attempted to read intelligently for myself and to master, it has seemed to me there has not been any clear tracing back the epidemic to arsenic only. In the "Lancet" of last week there is an article* which combats the point as to whether the illness is really derivable from the alcohol or from the arsenic, and therefore I am only quoting someone who has a very much better knowledge of the possibilities.

8274. You did not quote. You made a definite statement to me that these antiseptics you know did harm, and I am most anxious to have that evidence?—I should say that my own opinion on the matter is evidence. I hope it will be accepted as such. I do know of my own knowledge that if I drink beer containing these things I suffer. I have not taken arsenic, otherwise I should have been a living or dead instance of its effects.

8275. When you have had an impure beer disagree with you, have you had it analysed to see the amount of antiseptics in it?—No, because no analyst could tell me what are the effects or influences.

8276. You told me just now you could tell the different effects of these different preservatives on yourself?—I can by the influence on myself and the effects on my palate. I believe I am not wrong in assuming that there are a number of things not capable of being determined by analysts which can be told by the palate.

8277. These antiseptics can be easily recovered from the beer, and therefore when you have beer that disagreed with you, had you sent it to an analyst, and he had told you it contained such and such a percentage of bi-sulphite of lime or salicylic acid, you would have had evidence. But the mere statement is worthless?—May I direct your attention to one answer to one question put to Mr. Estcourt, the City Analyst of Manchester? He stated that he was absolutely unaware that brewers used any of these things even up to December last year.

8278. I want evidence of these substances you have mentioned being prejudicial?—Assuming that I had submitted a beer that I thought was prejudicial, which I knew of my own knowledge I dare not drink without getting heartburn and suffering from inconvenience, to Mr. Estcourt, do you think he would have found bi-sulphite of lime present in the beer?

8279. I have not the slightest doubt of it. If you had submitted it to any single chemist, asking him to look for poison, he would have found it. The beers sent to analysts were merely for adulterations, but you thought you were poisoned, and if you had mentioned any poison he would have told you without a shadow of doubt whether it was present?—A great number of men were inquiring very anxiously what was the cause of the deaths in Manchester, and yet the City analyst of Manchester was unaware that the brewers used any of these things. He was employed by brewers, and ought to have had the knowledge.

8280. (*Professor Thorpe.*) Where is the direct evidence that bi-sulphite of lime is capable of exercising a prejudicial action?—I presume it carries sulphur in some form or other. I have no knowledge, and I ought not to assume to answer your question. I am not at all sure there may be combinations between sulphur and arsenic which give rise to a much more deadly influence than when they are not present.

8281. I am talking about bi-sulphite of lime, not in conjunction with arsenic or anything else, and I ask you where is the evidence that bi-sulphite of lime is of an injurious nature?—There is no evidence, for the simple reason that few people know that brewers use such things.

8282. Bi-sulphite of lime is a thing known for a very long period of time; its therapeutic and physiological action has been studied. Where is the evidence that it is capable of injury?—Where is the evidence that arsenic would injure any beer until last November.

8283. (*Chairman.*) But you do not need an analyst because you know these different substances yourself?—I feel them.

8284. Which do you consider the worst, salicylic acid, bi-sulphite of lime, or borax?—They are all bad, but of the three probably salicylic acid is the worst, and it is very bad and harmful to have a combination of it in every article of food one takes. I think it is monstrous that we have these things in the form we now do. We get borax on almost every piece of meat and fish we have sent us by the butcher or fishmonger. Almost all the

* Alcohol and arsenic in the Etiology of Alcoholic neuritis. E. Farquhar Buzzard, *Lancet*, June 8, 1901, pp. 1593-5.

Mr. H. Stopes.

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wines which come to this country are charged with salicylic acid, and we get all these things in our beer. I contend that taking these things into our system is undesirable, and I know the effects on myself are prejudicial. I cannot define it, but I know it.

8285. (*Professor Thorpe.*) I should just like to positively and directly challenge a statement made as to the widespread use of antiseptics in articles of food. It is not the truth that borax is used practically in all meats and that salicylic acid is to be found practically in almost all wines and beers. That is not the fact. The exact proportion in which these things do occur has been recently inquired into by a Departmental Committee, and the precise nature of the facts is well established?—Do you say that bi-sulphite of lime is not used by nearly all brewers?

8286. I did not say that?—I contend that bi-sulphite of lime is used by all brewers. That is proveable. The other is only a matter of opinion.

Mr. H. Stopes

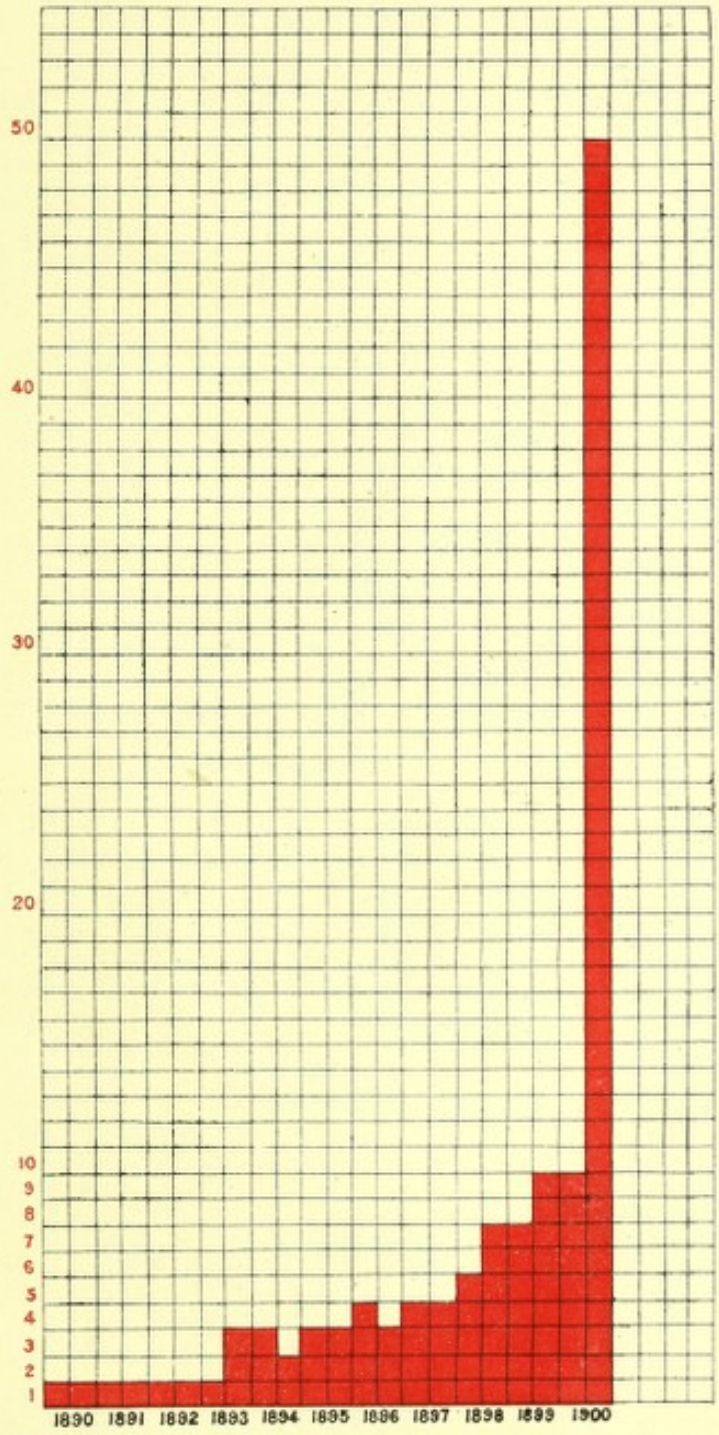
20 June 190

Appendix Nº 1.

CHARTS SUBMITTED BY Mr TATTERSALL.

BOROUGH OF SALFORD.

Chart showing Deaths from Peripheral Neuritis each half-year, from 1890 to 1900.



Each square represents one death.

& Graham Ltd Litho London.

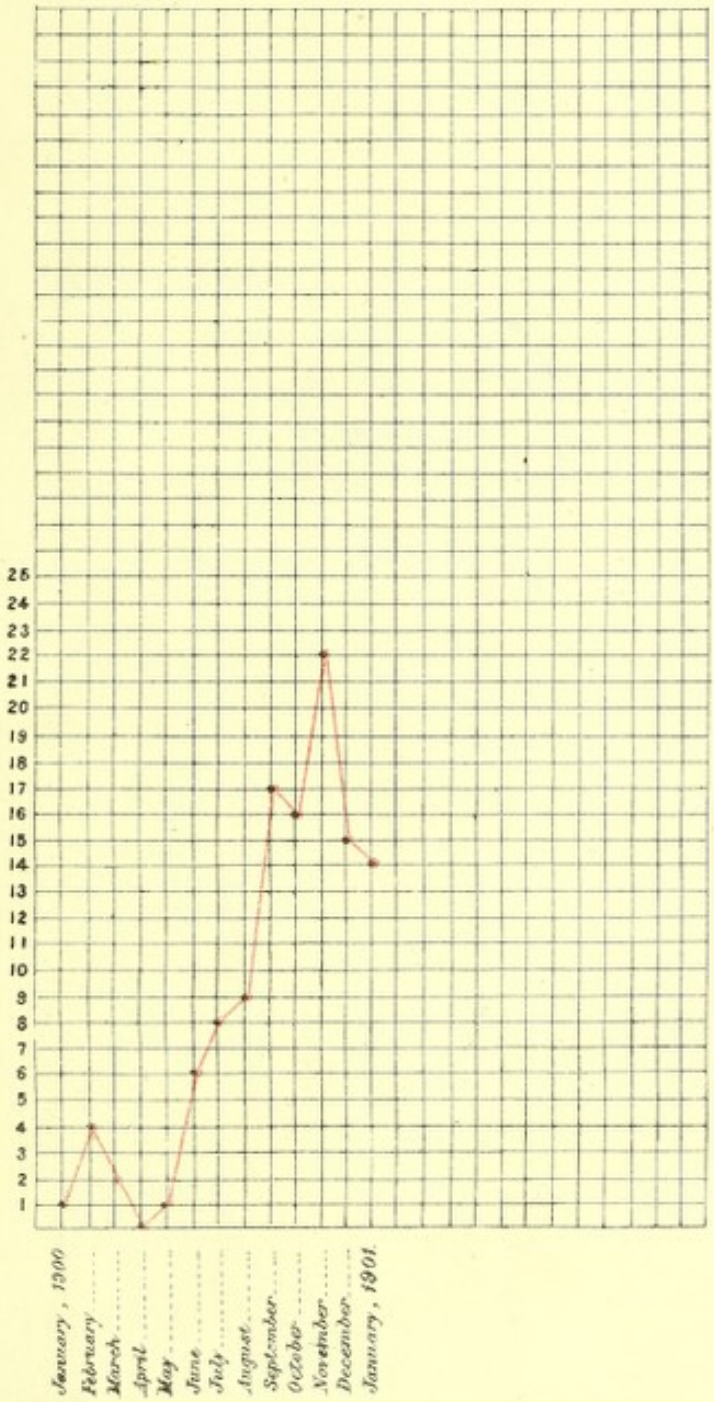
London School of Dental & Medical Medicine
15 JUN. 1929

Appendix Nº 2.

CHARTS SUBMITTED BY Mr. TATTERSALL.

BOROUGH OF SALFORD.

Monthly Deaths from Chronic Alcoholism Alcoholic Neuritis, Peripheral Neuritis, and Multiple Neuritis, from January 1st 1900 to January 31st 1901.



Weller & Graham Ltd Litho London.

1578 8.01.

15 JUN. 1929

APPENDICES TO EVIDENCE.

Nos. 1 and 2.

CHARTS handed in by Mr TATTERSALL.

Appendix No. 3.

APPENDIX No. 3.

Tables handed in by Mr. Niven.

A.—Deaths in Weeks from certain Diseases

Weeks.	Peripheral Neuritis.					Neuritis.					Alcoholism.					Cirrhosis of		
	1891.	1892.	1893.	1894.	1895.	1891.	1892.	1893.	1894.	1895.	1891.	1892.	1893.	1894.	1895.	1891.	1892.	1893.
1	-	-	-	1	-	-	-	1	1	-	2	1	1	-	1	-	1	-
2	-	-	-	-	-	-	-	-	-	-	1	1	2	1	-	2	1	2
3	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	2	-
4	-	-	-	1	-	-	-	-	-	-	1	-	-	2	1	2	1	1
5	-	-	-	-	-	-	-	-	-	-	1	-	2	1	-	1	1	2
6	-	1	-	-	-	-	-	-	-	-	2	-	1	2	1	1	3	1
7	-	1	1	-	3	-	-	-	-	-	1	2	1	1	-	5	2	1
8	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-	2	1	2
9	-	-	-	-	-	-	-	-	-	-	2	1	-	1	-	3	2	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	1	1
11	-	-	-	-	-	-	-	-	-	-	2	-	4	2	1	3	3	2
12	-	-	-	-	-	-	-	-	1	-	3	-	1	4	-	1	1	-
13	-	-	-	-	-	-	-	-	-	-	1	1	2	3	-	4	1	1
14	-	-	1	1	-	-	-	-	-	-	-	-	2	3	1	-	2	1
15	-	-	-	-	-	-	-	-	-	-	1	1	2	1	1	1	2	1
16	1	1	-	-	-	-	-	-	-	-	1	3	1	-	2	1	-	2
17	1	-	-	-	-	-	-	-	-	-	3	1	6	3	-	1	-	-
18	1	-	-	-	-	-	-	-	-	-	3	-	1	2	2	1	2	1
19	1	1	-	-	1	-	-	-	-	-	1	2	1	2	1	-	2	1
20	-	-	-	-	-	1	-	-	-	-	4	-	1	2	2	2	3	1
21	-	-	-	-	-	-	-	-	-	-	2	2	1	1	2	1	5	2
22	-	-	2	-	1	-	-	1	-	-	2	-	2	1	1	3	4	1
23	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	3	1	3
24	-	-	-	-	1	-	-	-	-	-	-	-	2	-	3	1	1	4
25	-	-	-	1	-	-	-	-	-	-	2	2	3	1	1	1	3	2
26	-	-	1	1	-	-	-	-	-	-	1	3	-	-	2	1	2	3
27	-	1	1	-	-	-	-	-	-	-	2	1	3	-	2	2	2	4
28	-	-	1	-	1	-	-	-	-	-	-	-	1	1	-	-	4	2
29	-	-	-	-	1	-	-	-	-	-	2	1	-	1	4	-	1	1
30	-	-	-	1	-	-	-	-	-	-	3	1	3	1	-	2	-	1
31	-	-	1	-	-	-	-	-	-	-	-	1	5	-	2	-	3	1
32	-	-	-	1	-	1	-	-	-	-	1	1	2	2	1	1	1	1
33	-	-	1	-	-	-	-	2	-	-	2	1	1	2	-	3	4	3
34	1	-	-	-	3	-	-	-	-	1	1	2	1	-	3	1	2	1
35	-	1	1	-	-	-	-	1	-	1	1	1	3	3	1	1	1	3
36	-	-	1	-	-	-	-	-	-	-	2	4	2	1	-	-	2	2
37	-	1	-	-	1	-	-	-	-	-	-	1	1	2	-	1	1	-
38	-	-	-	-	-	-	1	-	-	-	2	1	2	1	3	3	2	3
39	-	-	-	1	-	-	-	-	-	-	2	2	2	3	3	-	2	1
40	-	-	-	1	-	-	-	-	-	-	3	2	1	-	-	2	-	-
41	-	-	-	-	1	-	-	1	-	-	-	1	-	-	1	6	2	3
42	-	-	-	2	-	-	-	-	-	-	1	2	-	-	1	3	1	2
43	-	-	1	-	-	-	-	-	1	-	2	3	1	-	-	1	1	1
44	-	-	-	-	1	1	-	2	-	-	2	1	1	1	3	6	1	-
45	-	-	1	-	-	1	-	-	-	-	-	-	1	2	-	1	3	-
46	-	-	-	1	-	-	-	-	-	-	-	2	1	1	1	-	5	3
47	-	-	-	1	1	-	-	-	-	1	1	1	-	-	-	2	2	1
48	-	1	1	2	-	-	-	1	-	-	2	2	-	2	3	1	2	-
49	-	-	-	-	1	-		-	-	1	2	1	3	2	1	1	-	-
50	-	-	-	-	-	-	-	-	-	-	-	1	1	-		1	2	2
51	1	-	-	-	1	-	-	1	-	1	1	1	3	-	1	2	-	3
52	2	1	-	2	-	-	-	-	-	-	1	1	2	1	1	-	1	3
Total	8	9	14	17	17	4	2	10	3	5	72	56	78	63	55	82	92	76

APPENDIX No. 3.

Tables handed in by Mr. Niven.

in Manchester for the Five Years 1891–95.

Liver.		Liver Disease (other).					Gastritis (Adults).					Total.					Weeks.
1894.	1895.	1891.	1892.	1893.	1894.	1895.	1891.	1892.	1893.	1894	1895.	1891.	1892.	1893.	1894.	1895.	
3	2	–	–	–	1	1	1	1	1	1	–	3	3	3	7	4	1
–	–	1	1	–	2	–	1	–	1	–	–	5	3	5	3	–	2
1	1	–	–	–	–	1	2	–	–	1	1	4	2	–	3	3	3
1	2	–	1	–	–	–	–	3	1	1	1	3	5	2	5	4	4
1	1	1	1	–	1	2	–	1	1	–	–	3	3	5	3	3	5
–	2	1	–	–	–	1	1	–	–	–	2	5	4	2	2	6	6
2	3	2	1	1	1	1	–	–	–	–	1	8	6	4	4	8	7
3	–	–	–	2	–	1	–	–	–	–	–	3	1	5	4	1	8
1	3	2	1	–	4	–	–	1	1	–	–	7	5	1	6	3	9
–	1	–	–	–	–	1	–	–	2	1	–	2	1	3	2	3	10
3	1	–	–	–	–	–	1	1	–	–	–	6	4	6	5	2	11
2	2	1	1	–	–	2	–	1	–	–	1	5	3	1	7	5	12
1	3	1	–	1	1	–	–	–	–	2	2	6	2	4	7	5	13
1	1	1	–	1	1	1	–	–	–	–	1	1	2	5	6	4	14
–	1	–	–	–	–	1	–	1	–	–	–	2	4	3	1	3	15
2	3	2	–	–	–	1	–	–	–	1	–	5	4	3	3	6	16
1	1	–	–	2	–	–	1	1	1	–	–	6	2	9	4	1	17
1	1	–	2	2	1	1	1	–	–	1	–	6	4	4	5	4	18
1	1	2	–	–	1	1	–	–	1	–	–	4	5	3	4	4	19
3	3	–	2	–	1	–	–	–	1	1	2	7	5	3	7	7	20
–	3	–	–	–	–	–	1	–	–	2	–	4	7	3		5	21
1	3	–	2	1	–	–	–	–	–	1	1	5	6	7	3	6	22
–	2	1	3	1	–	–	–	–	1	–	1	4	5	6	1	3	23
–	2	–	4	–	1	2	–	1	–	–	–	1	6	6	1	8	24
3	3	–	–	–	–	–	–	1	1	1	1	3	6	6	6	5	25
–	–	5	–	–	–	1	–	2	1	–	–	7	7	5	1	3	26
–	–	–	–	–	1	2	–	1	–	–	–	4	5	8	1	4	27
1	–	–	–	–	–	1	1	–	–	–	2	1	4	4	2	4	28
4	1	–	3	–	–	–	–	–	1	–	1	2	5	2	5	7	29
3	–	1	1	–	–	–	–	–	–	1	–	6	2	4	6	–	30
2	2	–	3	2	–	2	3	–	1	1	–	3	7	10	3	6	31
–	2	2	–	1	–	–	–	1	1	1	–	5	3	5	4	3	32
3	1	1	1	1	1	–	2	–	2	–	–	8	6	10	6	1	33
2	–	–	1	1	1	2	–	–	–	1	–	3	5	3	4	9	34
1	1	–	1	–	1	1	1	–	1	–	–	3	4	9	5	4	35
1	1	2	–	1	–	–	–	–	–	–	2	4	6	6	2	3	36
1	–	–	1	3	1	1	1	1	–	–	1	2	5	4	4	3	37
1	2	–	–	2	1	1	–	1	–	–	1	5	5	7	3	7	38
2	7	–	–	1	2	1	–	–	1	1	–	2	4	5	9	11	39
1	–	1	1	1	–	–	2	–	1	–	1	8	3	3	2	1	40
–	2	–	5	2	1	–	–	–	–	1	–	6	8	6	2	4	41
1	–	1	–	–	–	–	1	1	2	1	–	6	4	4	4	1	42
3	1	2	–	1	–	–	–	–	–	1	1	5	4	4	5	2	43
–	–	1	–	–	1	2	1	1	–	–	–	11	3	3	2	6	44
2	2	–	1	–	1	2	–	–	2	–	1	2	4	4	5	5	45
2	1	–	–	1	1	–	–	1	–	–	–	–	8	5	5	2	46
1	3	–	1	1	2	2	–	–	–	–	–	3	4	2	4	7	47
1	2	–	1	1	–	2	–	–	–	–	1	3	6	3	5	8	48
1	–	1	1	–	1	2	–	–	–	–	2	4	3	3	4	7	49
–	–	–	–	–	1	1	–	–	2	–	–	1	3	5	1	2	50
2	1	2	1	1	–	–	–	–	–	1	–	6	2	8	3	4	51
2	–	–	2	–	–	1	–	–	–	–	–	3	5	5	5	2	52
68	74	34	43	31	51	41	21	21	27	22	27	221	223	230	204	219	Total.

Appendix No. 3.

B.—Deaths in Weeks from certain Diseases in

Weeks.	Peripheral Neuritis.					Neuritis (other).					Alcoholism.					Cirrhosis of		
	1896.	1897.	1898.	1899.	1900.	1896.	1897.	1898.	1899.	1900.	1896.	1897.	1898.	1899.	1900.	1896.	1897.	1898.
1	-	-	1	-	1	-	-	-	-	-	-	3	-	5	2	1	3	4
2	-	-	1	1	-	-	-	-	1	-	-	-	2	1	-	1	4	-
3	-	-	1	-	-	-	-	-	-	-	1	2	2	2	1	2	1	3
4	-	1	-	2	-	-	-	-	-	-	2	1	3	1	2	1	2	-
5	1	-	-	-	-	-	-	1	-	-	1	-	-	-	1	2	3	3
6	1	-	1	-	-	-	-	1	-	1	2	2	-	2	3	2	2	-
7	1	-	-	-	-	1	-	-	-	-	1	1	-	1	2	2	1	4
8	-	-	1	1	1	-	-	1	1	-	2	1	-	2	-	2	1	2
9	-	-	-	-	1	-	-	-	-	-	-	-	1	1	2	4	2	-
10	-	2	-	-	-	-	-	-	-	1	-	1	-	1	-	1	2	-
11	-	1	1	1	1	-	-	-	-	-	-	1	-	1	-	5	1	4
12	1	1	-	-	-	-	1	-	-	-	1	2	3	3	1	1	1	2
13	-	-	-	-	1	-	-	-	-	-	1	1	-	3	1	3	1	1
14	-	-	-	-	-	-	-	-	-	-	1	2	2	-	1	-	-	1
15	1	-	-	-	-	-	-	-	-	-	3	2	3	2	1	1	1	3
16	-	-	-	-	-	-	-	-	-	-	1	2	-	-	1	1	3	2
17	-	-	-	2	-	-	-	-	-	-	-	2	-	2	2	2	3	2
18	1	-	-	1	-	-	-	-	-	-	4	1	1	1	-	3	2	1
19	-	-	1	-	-	-	-	-	-	1	2	2	2	3	3	-	3	3
20	-	-	-	-	1	-	-	-	-	-	1	2	3	1	2	2	2	1
21	-	-	-	-	-	-	-	-	-	1	1	1	-	3	2	1	1	-
22	1	-	-	-	1	-	-	-	-	-	-	-	-	1	2	-	1	3
23	-	-	-	1	2	-	-	-	-	-	2	1	-	2	2	2	-	1
24	-	-	-	-	-	-	-	-	-	-	2	3	1	-	6	1	1	1
25	-	1	-	-	1	-	-	-	-	-	1	3	1	1	4	-	1	2
26	-	-	-	-	1	-	-	-	-	1	2	2	1	2	2	1	2	-
27	-	-	-	1	1	-	-	-	-	-	2	5	-	2	3	2	3	-
28	-	-	-	-	-	-	-	-	1	-	1	2	1	3	3	-	1	1
29	-	2	-	1	1	1	-	1	-	-	2	-	4	5	2	-	1	-
30	1	-	1	-	-	-	-	-	-	-	1	2	1	2	3	1	1	1
31	-	-	-	-	1	-	-	-	-	1	2	2	1	-	4	2	4	-
32	-	-	-	1	1	-	-	-	-	-	-	1	2	2	1	1	1	2
33	-	-	-	-	1	-	-	-	-	-	-	3	1	-	2	1	3	1
34	-	1	-	-	-	-	-	-	-	-	2	1	-	-	1	1	1	1
35	-	-	-	1	-	-	-	-	-	-	-	1	1	3	1	1	2	-
36	-	-	1	1	1	1	-	-	-	1	1	-	1	1	4	2	2	3
37	-	-	2	-	1	-	-	-	-	-	-	1	-	-	-	3	1	-
38	1	-	-	-	-	-	-	1	-	-	-	2	-	1	4	1	3	1
39	-	-	-	1	-	-	-	-	-	-	2	-	2	4	5	-	3	2
40	-	-	2	2	2	-	-	-	1	1	2	-	-	2	1	-	6	2
41	-	-	1	-	3	-	-	-	-	2	1	1	1	3	4	1	1	5
42	-	-	-	-	2	-	-	-	-	-	1	2	1	2	-	1	2	2
43	-	-	1	-	3	-	-	-	1	-	1	1	1	3	3	2	3	1
44	-	-	-	-	1	-	1	-	-	-	2	2	-	2	5	3	-	3
45	-	1	1	1	1	-	-	-	-	1	1	2	-	1	3	2	2	3
46	-	-	1	-	3	1	-	-	-	-	1	2	1	-	2	1	1	2
47	-	1	-	-	-	-	-	-	-	-	2	2	-	-	1	1	2	1
48	-	-	-	-	6	-	-	-	-	-	-	-	-	-	3	1	1	2
49	2	1	1	-	1	-	1	-	-	-	2	1	2	-	3	2	1	3
50	1	-	-	-	1	-	-	-	-	1	2	1	2	-	3	1	-	4
51	1	1	1	2	5	-	-	-	-	-	1	1	-	-	2	-	2	3
52	1	-	-	-	2	-	1	-	-	-	4	-	1	4	3	-	-	2
	14	13	19	20	48	4	4	5	5	12	64	74	48	81	109	71	91	88

MANCHESTER for the FIVE YEARS 1896—1900.

Appendix No. 3.

Liver.		Liver Disease (other).					Gastritis (in Adults)					TOTAL.					Weeks.
1899.	1900.	1896.	1897.	1898.	1899.	1900.	1896.	1897.	1898.	1899.	1900.	1896.	1897.	1898.	1899.	1900.	
3	-	-	3	2	-	-	-	1	1	-	1	1	10	8	8	4	1
-	1	-	1	-	-	1	-	1	-	-	-	1		3	3	2	2
-	1	1	1	-	-	1	-	1	2	-	-	4		8	2	3	3
1	-	1	1	-	1	-	-	-	2	-	-	4	5	5	5	2	4
4	1	1	1	-	-	-	-	-	-	-	-	5	4	4	4	2	5
-	2	-	1	2	-	-	-	-	1	-	-	5	5	5	2	6	6
2	3	-	-	-	-	1	-	-	-	1	-	5	2	4	4	6	7
-	2	-	1	-	-	1	1	-	1	-	-	5	3	5	4	4	8
1	1	1	-	-	2	-	-	-	-	-	1	5	2	1	4	5	9
-	5	-	-	1	2	-	-	-	3	-	-	1	5	4	3	6	10
1	3	1	2	-	1	1	-	-	2	-	-	6	5	7	4	5	11
3	4	-	-	-	-	-	-	-	-	-	-	3	5	5	6	5	12
-	2	-	1	1	-	-	1	-	-	-	1	5	3	2	3	5	13
1	-	1	1	-	-	-	-	-	-	-	1	2	3	3	1	2	14
3	2	-	1	2	1	-	1	-	-	-	-	6	4	8	6	3	15
2	1	1	-	-	-	-	-	1	-	1	-	3	6	2	3	2	16
-	3	1	1	-	1	-	-	2	-	-	-	3	8	2	5	5	17
3	2	-	1	3	1	1	-	1	2	-	2	8	5	7	6	5	18
1	1	-	-	-	-	-	-	1	-	1	-	2	6	6	5	5	19
-	1	-	4	1	1	-	1	-	2	-	1	4	8	7	2	5	20
3	4	-	-	-	-	2	1	-	1	-	1	3	2	1	6	10	21
2	4	-	-	1	-	-	-	2	-	-	1	1	3	4	3	8	22
-	2	2	1	-	-	2	1	1	-	-	-	7	3	1	3	8	23
4	2	-	-	1	1	1	1	-	-	-	1	4	4	3	5	10	24
1	2	1	1	-	-	-	1	-	2	-	1	3	6	5	2	8	25
5	2	1	2	-	-	-	-	2	-	1	-	4	8	1	8	6	26
1	4	-	-	-	-	-	1	-	-	-	-	5	8	-	4	8	27
4	5	1	-	1	1	1	1	-	-	-	-	3	3	3	9	9	28
4	1	-	-	-	-	1	2	1	-	-	-	5	4	5	10	5	29
3	-	2	-	1	-	-	-	1	-	-	-		4	4	5	3	30
5	4	-	1	1	-	2	1	1	-		-	5	8	2	6	12	31
4	3	1	-	-	-	-	-	-	-	-	-	2	2	4	7	5	32
4	1	4	1	1	1	1	-	1	-	-	-	5	8	3	5	5	33
1	2	-	-	-	1	-	1	2	1	-	-	4	5	2	2	3	34
5	1	1	-	-	-	-	-	-	-	1	2	2	3	1	10	4	35
-	1	2	-	-	-	-	-	-	1	-	1	6	2	6	2	8	36
-	3	-	-	2	-	-	1	1	3	-	-	4	3	7	-	4	37
1	3	-	1	1	1	2	-	1	1	-	2	2	7	4	3	11	38
1	2	-	1	1	-	-	1	-	1	-	1	3	4	6	6	8	39
1	2	-	2	1	-	-	-	-	1	-	1	2	8	6	6	7	40
-	3	1	-	-	-	-	-	-	-	1	-	3	2	7	4	12	41
1	2	1	1	-	-	-	2	-	3	-	-	5	5	6	3	4	42
4	1	-	2	1	1	-	2	-	1	-	-	5	6	5	9	7	43
1	3	2	-	2	-	-	-	-	-	-	-	7	3	5	3	9	44
2	4	2	1	1	-	1	-	-	-	1	-	5	6	5	5	10	45
2	2	1	-	3	-	-	1	2	-	-	1	5	5	7	2	8	46
2	3	-	-	1	-	-	1	1	-	1	-	4	7	2	3	4	47
2	4	-	1	1	1	1	-	1	1	-	-	1	3	4	3	14	41
-	3	-	1	-	-	2	2	1	-	-	-	8	6	6	-	9	49
1	4	-	-	-	-	2	2	-	-	-	1	6	1	6	1	12	50
	6	-	-	-	-	-	-	2	-	2	-	2	6	4	6	12	51
2	8	-	-	-	1	-	-	-	-	-	1	5	1	3	7	14	52
98	126	30	36	32	18	24	26	28	32	11	21	240	246	224	228	340	TOTAL.

Appendix No. 4.

APPENDIX No. 4.

Papers handed in by Mr. Niven.

TABLE C.—MANCHESTER.

Deaths from Peripheral Neuritis in Sex and Age Groups.

Year.	Under 20 Years.		20–25.		25–35.		35–45.		45–55.		55–65.		65 Years and upwards.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1891	–	–	–	–	–	2	1	3	–	1	–	1	–	–
1892	–	–	–	1	–	2	1	3	–	–	–	1	1	–
1893	–	–	–	–	–	2	2	5	–	1	1	1	1	1
1894	–	–	–	–	–	3	1	9	1	2	1	–	–	–
1895	–	–	–	–	–	–	1	8	3	1	–	2	2	–
1896	–	–	1	–	–	1	–	2	1	7	–	2	–	–
1897	–	–	–	–	1	1	–	2	1	6	–	2	–	–
1898	–	–	–	–	–	3	2	5	1	6	–	2	–	–
1899	1	–	–	–	2	1	4	3	3	4	–	2	–	–
1900	–	–	–	1	1	5	4	13	4	10	4	5	1	–
Total	1	–	1	2	4	20	16	53	14	38	6	18	5	1

Deaths from Neuritis (other) in Sex and Age Groups.

Year.	Under 20 Years.		20–25.		25–35.		35–45.		45–55.		55–65.		65 Years and upwards.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1891	–	–	–	–	–	–	1	1	–	1	–	1	–	–
1892	–	–	–	–	–	–	–	1	–	1	–	–	–	–
1893	–	–	–	–	–	–	3	1	1	1	–	3	–	1
1894	–	–	–	–	1	1	–	1	–	–	–	–	–	–
1895	–	–	–	–	1	1	–	3	–	–	–	–	–	–
1896	–	–	–	1	–	1	–	–	–	1	1	–	–	–
1897	–	–	–	–	–	–	–	1	–	2	–	–	–	1
1898	–	–	–	–	–	2	–	1	1	1	–	–	–	–
1899	–	–	–	–	–	–	–	3	–	–	–	2	–	–
1900	–	–	–	–	–	1	2	2	2	3	1	1	–	–
Total	–	–	–	1	2	6	6	14	4	10	2	7	–	2

Appendix No. 4.

TABLE D.

HANDED in by Mr. *Niven*, Manchester.

MANCHESTER.—Deaths from PERIPHERAL NEURITIS and ARSENICAL POISONING from November 25th, 1900, to February 19th, 1901.

Date of Death.	Initials.	Sex.	Age.	Occupation.	Certified or Inquest.	Medical Officer's Classification Cause of Death.	Hospital (which).
1900. 26 Nov.	J. A.	M.	55 years	French polisher	Certified	Peripheral neuritis, phrenic paralysis.	—
30 "	W. H. H.	M.	43 "	Sick visitor for provident society.	Certified	Cirrhosis of liver, peripheral neuritis.	—
29 "	J. F.	M.	70 "	Fustian cutter (retired)	Certified	Senile decay, peripheral neuritis, hemiplegia.	—
25 "	M. E. P.	F.	44 "	Wife of warehouse porter.	Certified	Peripheral neuritis, 21 days; cerebral hæmorrhage, 5 hours.	—
25 "	G. R.	M.	58 "	Formerly a warehouseman.	Certified	Ch. peripheral neuritis, 1 year; dementia.	—
25 "	M. L.	F.	56 "	Wife of a joiner	Certified	Ch. peripheral neuritis, 1 year; dementia.	—
1 Dec.	W. B.	M.	56 "	Warehouse porter	Certified	Peripheral neuritis, 5 months; asthenia.	—
6 "	F. R.	F.	47 "	Wife of concretor	Inquest	She died from arsenic poisoning, no evidence to show how caused.	—
11 "	A. O.	F.	49 "	Wife of wood pattern maker.	Certified	Peripheral neuritis, cardiac failure.	—
10 "	E. H.	F.	50 "	Widow of bricksetter	Inquest	She died from bronchitis and alcohol, and arsenical poisoning.	Crumpsall Workhouse.
10 "	J. D.	F.	45 "	Widow of fitter	Inquest	She died from alcohol and arsenical poisoning.	Crumpsall Workhouse.
17 "	W. S.	M.	48 "	Billiard marker	Certified	Peripheral neuritis, exhaustion	Ancoats Hospital.
20 "	S. J. K.	F.	48 "	Property repairer	Certified	Peripheral neuritis, mitral regurgitation, hypostatic pneumonia, cardiac failure.	—
20 "	A. G.	F.	59 "	Wife of trunk maker	Inquest	She died from pneumonia, hastened by arsenical poisoning.	—
14 "	J. B.	M.	51 "	Hawker	Inquest	He died from peripheral neuritis from arsenic poisoning.	Crumpsall Workhouse.
16 "	A. S.	F.	32 "	Wife of labourer	Certified	Peripheral neuritis, phthisis, exhaustion.	Crumpsall Workhouse.
18 "	E. A. C.	F.	47 "	Wife of hardware salesman.	Certified	Peripheral neuritis	Prestwich Workhouse.
22 "	M. J. C.	F.	46 "	Wife of labourer	nquest	She died from cardiac syncope, due to peripheral neuritis from arsenic poisoning.	—
22 "	M. T.	F.	49 "	Widow of engraver	Inquest	She died from tubercular disease, accelerated by arsenical and alcoholic poisoning.	—
23 "	J. A. S.	F.	44 "	Wife of painter	Inquest	She died from chronic arsenic poisoning.	—
25 "	M. G.	F.	50 "	Widow of porter	Inquest	She died from pneumonia resulting from peripheral neuritis.	—
25 "	J. C.	M	34 "	Tinplate worker	Inquest	He died from cirrhosis of the liver, accelerated by arsenical poisoning.	Crumpsall Workhouse.
1901. 2 Jan.	E. I.	F.	62 "	Wife of saw maker	Inquest	She died from peripheral neuritis due to arsenic poisoning.	
2 Jan.	C. N.	F.	54 "	Unknown	Inquest	Heart failure produced by alcoholic peripheral neuritis.	
1900. 0 Dec.	M. N.	F.	38 "	Wife of labourer	Inquest	She died from paralysis of the diaphragm due to arsenical poisoning.	Crumpsall Workhouse
1901. 1 Jan.	M. L.	F.	59 "	Wife of clog iron maker	Inquest	She died from cardiac failure due to alcohol and accelerated by arsenical poisoning.	Crumpsall Workhouse.

Appendix No. 4.

TABLE D.—MANCHESTER.—Deaths from Peripheral Neuritis and Arsenical Poisoning, &c.—*continued.*

Date of Death.	Initials.	Sex.	Age.	Occupation.	Certified or Inquest.	Medical Officer's Classification Cause of Death.	Hospital (which).
1901. 2 Jan.	J. M.	M.	40 years	A tin-whistle player	Inquest	He died from peripheral neuritis due to chronic arsenical poisoning.	Crumpsall Workhouse.
1900. 30 Dec.	M. M.	F.	55 „	Wife of painter	Inquest	She died from heart disease accelerated by arsenic poisoning.	Crumpsall Workhouse.
1901. 8 Jan.	J. C.	M.	40 „	Street pavior	Certified	Peripheral neuritis mitral regurgitation Haematamesis.	—
5 „	A. H.	M.	31 „	Beer retailer	Certified	Phthisis, peripheral neuritis	—
7 „	L. B.	F.	41 „	Wife of painter	Inquest	She died from pneumonia due to paralysis of the diaphragm from arsenical poisoning.	Royal Infirmary.
6 „	E. D.	F.	41 „	Widow of furniture remover.	Inquest	She died from meningitis due to peripheral neuritis from alcoholic poisoning.	—
1900. 2 Dec.	A. R.	F.	38 „	Wife of ———	Inquest	She died from cardiac syncope due to arsenic poisoning.	—
1901. 10 Jan.	J. W.	M.	47 „	Army pensioner	Certified	Alcoholism, peripheral neuritis (? Beer), exhaustion.	—
7 „	E. J.	F.	29 „	Wife of theatrical manager.	Certified	Alcoholic neuritis, six months; coma, two days.	—
13 „	P. M.	M.	51 „	Market porter	Inquest	He died from phthisis accelerated by arsenical poisoning.	Crumpsall Workhouse.
1900. 19 Dec.	T. B.	F.	42 „	Wife of hawker	Inquest	Heart failure following pneumonia, the result of Ch. alcoholism and arsenical poisoning.	Wilkington Workhouse.
1901. 20 Jan.	W. S.	M.	43 „	Plumber and gasfitter	Inquest	He died from arsenic poisoning	—
15 „	E. K.	F.	43 „	Widow of hawker	Inquest	She died from cardiac failure due to liver disease and arsenical poisoning.	Crumpsall Workhouse.
1900. 23 Nov.	M. M.	F.	48 „	Widow of labourer	Inquest	She died from arsenical neuritis.	Crumpsall Workhouse.
„	M. J. D.	F.	40 „	Wife of tailor	Inquest	She died from arsenical poisoning.	Crumpsall Workhouse.
1901. Jan.	M. A. T.	F.	61 „	Wife of wood case maker.	Certified	Peripheral neuritis, cardiac failure	—
„	M. S.	F.	54 „	Widow of iron turner	Certified	Alcoholic paralysis	—
5 Feb.	W. D.	M.	53 „	Bill distributor	Inquest	He died from cardiac failure, hastened by arsenical poisoning and tuberculosis.	Royal Infirmary.
3 „	M. S.	F.	54 „	Wife of plumber	Certified	Phthisis, alcoholic peripheral neuritis	—
6 „	A. R.	F.	53 „	Wife of stationary fireman.	Certified	Alcoholic peripheral neuritis.	—
7 „	J. T.	M.	42 „	Bolt-maker	Inquest	He died from uræmia, following peripheral neuritis from arsenical and alcoholic poisoning.	—
1 „	A. M.	F.	30 „	Charwoman	Inquest	She died from cardiac failure, resulting from arsenical neuritis.	Crumpsall Workhouse.
10 „	E. O.	F.	43 „	Wife of plumber	Inquest	She died from chronic arsenical poisoning taken in beer.	Royal Infirmary.
11 „	B. E.	M.	47 „	Joiner	Inquest	He died from phthisis accelerated by arsenical poisoning.	—
12 „	C. M.	F.	42 „	Wife of tailor	Inquest	She died from tubercular disease, aggravated by arsenical poisoning.	Crumpsall Workhouse.
13	A. S.	F.	47 „	Wife of maker-up	Inquest	She died from arsenical poisoning.	Crumpsall Workhouse.
13 „	P. L.	M.	37 „	Warehouse porter	—	Peripheral neuritis, phthisis.	—
19 „	B. F.	F.	60 „	Wife of street sweeper	Inquest	She died from bronchitis and heart disease, aggravated by arsenical poisoning.	—

APPENDIX No. 5.

Appendix No. 5.

PAPERS handed in by MR. GORDON SALAMON.

FIRST AND SECOND REPORTS OF THE EXPERT COMMITTEE APPOINTED BY THE MANCHESTER BREWERS' CENTRAL ASSOCIATION.

First Report, December 1st, 1900

Gentlemen,—Our investigations and inquiries so far as they have gone point to the conclusion that the materials in current use in brewing in Manchester are free from arsenic, with the exception of certain sugars supplied by Messrs. Bostock and Company, Limited, of Liverpool. In appearance and price these sugars are indistinguishable from perfectly pure sugars.

We therefore recommend to the Association the immediate adoption for the present of the following provisional precautions:—

1. That all beer in the brewing of which any sugar bought from Messrs. Bostock and Company, Limited, has been used should be at once recalled, and if found to be contaminated should be destroyed.
2. That no beer should be sent out until it has been tested and shown to be free from arsenic.
3. That a certificate of freedom from arsenic should be given in respect of beer so tested, and that only such beer should be sold.

In view of the importance of the subject we should recommend that the Association should take the management of the testing by its officials, and that the certificates should be issued in the name of the Association.

If these precautions be adopted we are of opinion that they will be effectual in preventing further mischief.

We desire to gratefully recognise the cordial co-operation and assistance of the Medical Officers of Health for Manchester and Salford, which have greatly lightened our labours.

We are, Gentlemen,
Yours faithfully,

(Signed) *Lauder Brunton,*
J. Fletcher Moulton,
Thos. Stevenson,
Alfred Gordon Salamon,
Arthur P. Luff,
Samuel Buckley.

Second Report December 15th, 1900.

Gentlemen,—The Commission has now examined the sugars and all the other materials used in brewing in Manchester (with the exception of the malt), and they consider that it is clearly established that the arsenic found in deleterious quantities in the beer has been solely due to the contamination by arsenic of the sugars supplied by Messrs. Bostock and Company, Limited, of Liverpool. The arsenic in these sugars was undoubtedly derived from the impure sulphuric acid used in their manufacture.

The measures recommended by the Commission a few days ago have, they learnt, been effectively carried out. The whole of the beer in the manufacture of which any Bostock sugar was used has been destroyed, and there is no further danger from this source.

All the other brewing sugars on the English market have been analysed, and have been found to be quite free from arsenic.

In view of the importance of the matter, the Commission have instituted inquiries as to the manufacture of brewing sugars in the United Kingdom, and in this they have been assisted by the whole of the manufacturers of such sugars—in a body—voluntarily offering them the opportunity of examining into the mode in which they conduct the manufacture. These manufacturers have stated collectively that it is, and always has been, their custom to use only acid free from arsenic, and they have requested the Commission to examine their invoices, works, etc., in order to verify these statements. Lack of time has prevented this being done by personal examination up to the present, but the fact that all the specimens of brewing sugars as well as of glucose used for other purposes on the market have been found to be free from arsenic, and the absence of any previous cases in which arsenic has been in such products, leave in the mind of the Commission no doubt that this statement, when examined into, will be found to be correct.

The Commission is quite unable to explain how Messrs. Bostock and Company, Limited, came to employ an acid of the character actually used by them. The absolute necessity of using an acid free from arsenic in the manufacture of an article for human consumption must have been evident to everybody technically connected with the manufacture, and such acid is a common article of commerce. The price of the sugars in question was as high as any in the market, and, apart from this, the quantity of acid used in the manufacture of the sugars is so small that the difference in cost of the best and the worst would only make a difference of a fraction of a penny per hundredweight of sugar. So that it is not a case of an attempt to cheapen production by the use of lower priced materials. The Commission believe that it is this inexplicability which has rendered the matter so serious, and that the extent to which the mischief spread before it was detected was mainly due to the fact that the use of an acid containing arsenic in the manufacture of sugars was a contingency so improbable that it never occurred to those purchasing the sugars that it was possible that any danger could arise from that quarter.

The Commission has been unable to detect the presence of arsenic in brewing materials other than sugar supplied by Messrs. Bostock and Company, Limited, but they are aware that it has been asserted that traces of arsenic have been found in various samples of malt and hops. If such traces exist, they have probably been introduced in the operation of kilning, and the Commission propose to examine more fully into the matter. None of the specimens of hops have as yet yielded any traces. In any case, the amount so introduced would appear to be exceedingly minute, and not sufficient to have any deleterious effect.

The most important matter for the moment is to secure the adequate testing of beer in order that the public may be protected from all further mischief. Arsenic is a substance which can be detected in the most infinitesimal quantities by those who are practised in the tests, but these tests are so delicate that they are apt to mislead those who have not had experience in their application, and this is more particularly the case when the test is to be applied to a complex substance such as beer. Accordingly the Commission have thought it necessary to investigate and determine what is the most suitable method of testing beers for arsenic.

Test.—The Commission recommend that the Reinsch test should be used in preference to all others at present known, because their investigations have satisfied them that it is the best and most reliable test for arsenic in beer. The mode of performing it is as follows:—

Take 200 cc. of the beer in a porcelain evaporating dish. Raise the liquid to the boiling point, and then add 30 cc. of pure concentrated hydrochloric acid. Insert a piece of pure bright copper foil, about a quarter of an inch by half an inch in size, and keep the solution gently boiling for 45 minutes. If at the end of that time the copper remains bright and red, the beer is free from arsenic.

If a deposit is obtained on the copper the foil is to be washed successively with water, alcohol, and ether (care being taken that these are pure), dried at a temperature not exceeding 100° C., and subjected to slow sublimation in a thin reduction tube of small section, and not less than 2 inches long, the upper portion of which should be warmed before the sublimation begins. For the purpose of the sublimation a small spirit lamp flame should be used. If any sublimate is obtained, it must be examined under a magnifying power of about 200 diameters. Any sublimate which does not show well-defined octahedral or tetrahedral crystals is not to be considered arsenical.

N.B.—It must be borne in mind that the blackening of the copper or a deposit thereon from the preliminary operation does not demonstrate the presence of arsenic in beer. Abundant blackening and deposit may be obtained from the purest beer.

Lauder Brunton.
Thos. Stevenson.
Alfred Gordon Salamon.
Arthur P. Luff.
Samuel Buckley.
J. Fletcher Moulton.

Appendix No. 6.

APPENDIX No. 6.

PAPER HANDED IN BY MR. E. W. T. JONES.

Reprint of article in "Chemical News," Jan. 18, 1901.

ARSENIC IN BEER.

BY MR. E. W. T. JONES.

I beg to lay before the readers of the "Chemical News" the method I have been using for the detection of arsenic in beer since the beginning of December last, when the scare inundated most public analysts like myself with beer samples. I do so, notwithstanding the report of the method published by the Commission of the Manchester Brewers' Association, because although in the main their method differs but little from mine, I personally prefer my procedure because it secures immediately on the addition of the acid the requisite conditions of Reinsch's test for the deposition of the arsenic on the copper. Before the addition of the hydrochloric acid there is no fear of arsenic being lost by the evaporation.

I also append the method I have employed with success for the estimation of the arsenic on the lines of Dr. Clark ("Journ. Chem. Soc.," 1893).

Qualitative Test.

250 c.c. of the beer are evaporated in a porcelain dish over a low Fletcher burner to about 100 c.c., then 25 c.c. of pure strong hydrochloric acid are added, and into the still boiling liquid is put a piece of fine copper gauze (I prefer this to foil), about 1 inch by ½ inch, and the boiling continued for a quarter of an hour; if no darkening occurs by this time certainly less than 1-40th grain per gallon of arsenic is present. If the gauze is suspiciously darkened, wash with hot distilled water, then with alcohol, and dry. Roll up into a small size, and introduce into a small glass tube about 3 inches long, and heat the gauze with a very small flame whilst holding the tube in a horizontal position; examine any sublimate under the microscope, using a 1-5th objective. The tubing I have found very convenient is of elliptical section (I had it made originally for absorption spectroscopical work); it lies conveniently on the stage of the microscope, held on to the usual glass slips by two thin india-rubber bands, and I prepare such pieces of tube by drawing out to furnish a shoulder for the piece of gauze, and also that I may concentrate the sublimate in the narrower part.

Unmistakable octahedral or tetrahedal crystals of arsenious oxide are obtained without the least difficulty by the above procedure when 1-20th grain per gallon is present.

For glucose, syrups, jams, etc., I use 50 grms., and make to 100 c.c. at once with hot distilled water, and proceed in the same way.

To prepare the copper gauze - beat a strip about an inch wide to redness in a Bunsen burner, and then remove the black oxide with nitric acid, well wash, and dry; from these beautifully bright strips I cut pieces off about ¼ inch wide for the qualitative test, and about 3½ inches long for the rolls I use for the quantitative tests.

Quantitative Test.

250 c.c. (or more) of the beer are evaporated as above in a porcelain dish to about 100 c.c., and 25 c.c. of pure strong hydrochloric acid added, then a piece of the pure bright copper gauze 1 inch × 3½ inches, in the shape of a loose roll, is put in, and the liquid is kept just on the boil with occasional stirring for, say, an hour, addition of hot distilled water being made from time to time to prevent the bulk by evaporation getting too small; considerable concentration is advantageous before the bulk is brought back with distilled water. The roll of gauze is now removed and washed with hot distilled water, the first washings being returned to the dish, and then another roll is put in, and the boiling continued.

The blackened and thoroughly washed roll is now put into a small beaker, ¾ inch diameter and 1½ inch high, containing 5 c.c. N. sodic hydrate diluted to just cover the roll, and then three or four drops of a 10 vol. solution of peroxide of hydrogen solution added; by moving the coil up and down this solution is mixed, and on standing in the cold the gauze is gradually denuded of its black coating, and on acquiring its original colour is removed and washed into another larger beaker, these washings being reserved.

APPENDIX No. 7.

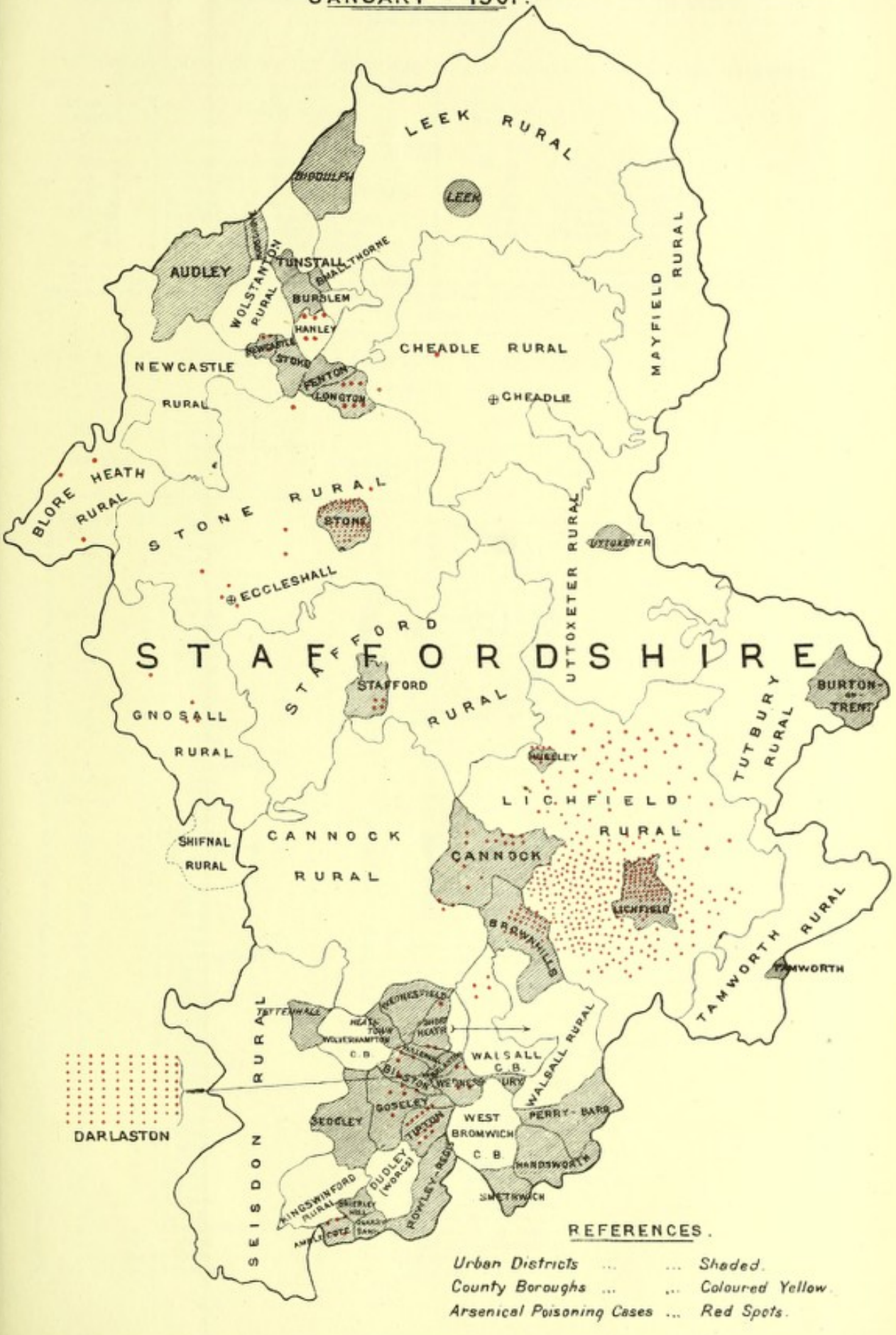
"Spot Map" of the County of Staffordshire, shewing Distribution of Cases of Poisoning by Arsenic in Beer.

STAFFORDSHIRE COUNTY COUNCIL.

APPROXIMATE NUMBER OF CASES OF POISONING BY ARSENIC IN BEER 667.

SPOT MAP HANDED IN BY DR REID SHOWING DISTRIBUTION OF CASES.

JANUARY 1901.



REFERENCES.

Urban Districts ... ... *Shaded.*
County Boroughs ... ... *Coloured Yellow.*
Arsenical Poisoning Cases ... *Red Spots.*

Weller & Graham Ltd Litho London.

15 JUN. 1929

APPENDIX No. 8.

Appendix No. 8.

INFORMATION FURNISHED BY DR. G. REID, SUPPLEMENTARY TO HIS EVIDENCE OF 13TH MARCH, 1901.

I.—LIST OF BREWERS WHOSE BEER WAS FOUND ARSENICAL IN COUNTY STAFFORD.

Distinctive Number.	Name of Brewery.	Distinctive Number.	Name of Brewery.
No. 1	Manchester Brewery Company.	No. 35	Newport Brewery Company.
,, 3	Joule & Son, Stone.	,, 47	Lichfield Brewery Company.
,, 4	Ridgway & Co., Newcastle-under-Lyme.	,, 54	Price, West Bromwich.
,, 6	Farquhar's, Burslem.	,, 56	Pritchard, Darlaston.
,, 26	Market Drayton Brewery Company.	,, 78	*Bates, West Bromwich.
,, 27	Pearce & Co., Market Drayton.	,, 88	Harper's, Bilston.
,, 28	Wright & Co., Market Drayton.		

NOTE.—Brewery 5, to which Dr. Reid refers (Question 2000), as having come under suspicion on medical grounds but whose beer was not found arsenical by the County Analyst, was Bents' Brewery, Stone.

* Very minute trace.

II.—DETAILED LIST OF BREWERIES WHOSE BEER WAS ANALYSED

First Inquiry, 3 to 21 December 1901.

Date of Collection.	Sanitary District.	Brewery.		Arsenic Present, Positive or Negative.
		Distinctive Number.	Name.	
3 December 1900	Longton	1	Manchester Brewery Company	+
3 ,, ,,	ditto	2	Worthington & Co., Burton	—
3 ,, ,,	ditto	3	Joule and Son, Stone	+
3 ,, ,,	Fenton	4	Ridgway & Co., Newcastle	+
3 ,, ,,	Stoke-on-Trent	5	Bent's, Stone	—
3 ,, ,,	ditto	6	Parker's, Burslem	+
3 ,, ,,	Brownhills	47	Lichfield Brewery Company	+
3 ,, ,,	ditto	89	Blencowe & Co., Cannock	—
3 ,, ,,	ditto	90	Boulter and Sons, Brownhills	—
3 ,, ,,	ditto	47	Lichfield Brewery Company	—
3 ,, ,,	ditto	91	Home Brewed, "Hawthorn," Walsall Wood	—
3 ,, ,,	ditto	22	Bindley & Co., Burton	—
3 ,, ,,	ditto	70	Robert-', Brownhills	—
3 ,, ,,	ditto	71	Lichfield City Brewery Company	—
3 ,, ,,	ditto	85	Flower and Sons, Stratford	—
4 ,, ,,	ditto	19	Showell's, Oldbury	—
4 ,, ,,	ditto	87	South Stafford Brewery Company	—
4 ,, ,,	ditto	50	Butler & Co., Wolverhampton	—
4 ,, ,,	Stoke-on-Trent	7	Pim & Co., Stoke-on-Trent	—
4 ,, ,,	ditto	8	Walker & Co, Burton	—
4 ,, ,,	ditto	9	Bass & Co., Burton	—
4 ,, ,,	ditto	10	Allsop & Co., Burton	—
4 ,, ,,	ditto	11	Charrington & Co., Burton	—
4 ,, ,,	Burslem	12	Robinson & Co., Burton	—
4 ,, ,,	Stoke-on-Trent	13	Bunting & Co., Uttoxeter	—
4 ,, ,,	Burslem	14	Alton Brewery Company	—
4 ,, ,,	ditto	15	Ind Coope & Co., Burton	—
4 ,, ,,	ditto	16	Eley's Stafford Brewery	—
4 ,, ,,	ditto	17	Malam,	—
4 ,, ,,	ditto	18	Salt & Co., Burton	—
5 ,, ,,	ditto	19	Showell's, Stoke-on-Trent	—
5 ,, ,,	ditto	20	Burton Brewery Company	—
5 ,, ,,	Stoke-on-Trent	19	Showell's, Stoke-on-Trent	—
5 ,, ,,	Fenton	21	Stretton Brewery Company	—
5 ,, ,,	ditto	14	Alton Brewery Company	—
5 ,, ,,	Bilston	51	Woodall, West Bromwich	—
5 ,, ,,	ditto	1	Manchester Brewery Company	—
5 ,, ,,	ditto	19	Showell's, Oldbury	—
5 ,, ,,	ditto	52	Wolverhampton and Dudley Company	—
5 ,, ,,	ditto	53	Home Brewed, "Oak and Ivy Inn"	—
5 ,, ,,	Wednesbury	54	Price, West Bromwich	+
5 ,, ,,	ditto	55	Cheshire's Brewery Company	—
5 ,, ,,	ditto	56	Pritchard, Darlaston	+
5 ,, ,,	ditto	57	Home Brewed, "Noah's Ark"	—
5 ,, ,,	ditto	47	Lichfield Brewery Company	+
6 ,, ,,	Tipton	58	Jordan, Oldbury	—
6 ,, ,,	ditto	59	Moore and Simpson, Perry Barr	—
6 ,, ,,	ditto	60	Birmingham Brewery Company	—
6 ,, ,,	Tipton	61	North Worcestershire Company	—
7 ,, ,,	Fenton	5	Bent's, Stone	—
7 ,, ,,	Longton	22	Bindley & Co. Burton	—
7 ,, ,,	ditto	8	Walker & Co., Burton	—
7 ,, ,,	Cheadle (Rural)	23	Truman & Co., Burton	—
7 ,, ,,	ditto	24	Bell & Co., Burton	—
7 ,, ,,	ditto	5	Bent's, Stone	—
7 ,, ,,	Longton	5	ditto	

Appendix No. 8.

II.—Detailed List of Breweries whose Beer was Analysed—*continued.*

Date of Collection.	Sanitary District.	Brewery. Distinctive Number.	Brewery. Name.	Arsenic Present, Positive or Negative.
7 December 1900	Longton	5	Bent's, Stone	—
7 " "	ditto	1	Manchester Brewery Company	—
7 " "	Stone (Rural)	25	Home Brewed, "Bird-in-Hand," Hilderstone	—
7 " "	Stone	5	Bent's, Stone	—
7 " "	ditto	5	ditto.	—
7 " "	ditto	3	Joule & Son, Stone	+
7 " "	Kingswinford (Rural)	62	Ellwell & Co., Brierly Hill	—
7 " "	ditto	63	Wordsley Brewery Company	—
7 " "	ditto	64	Worcestershire Company	—
7 " "	ditto	65	Home-Brewed, "Bird-in-Hand," Wordsley	—
7 " "	ditto	66	Home-Brewed, "George and Dragon," Wordsley.	—
7 " "	ditto	19	Showell's, Oldbury	—
8 " "	Newcastle (Rural)	10	Allsop's, Burton	—
8 " "	ditto	26	Market Drayton Brewery Company	+
8 " "	Blore Heath (Rural)	9	Bass & Co., Burton	—
8 " "	ditto	27	Pearce & Co., Market Drayton	+
8 " "	ditto	28	Wright & Co., Market Drayton	+
8 " "	Stone (Rural)	16	Eley's Stafford Brewery	—
8 " "	Bilston	5	Bent's, Stone	—
8 " "	ditto	56	Pritchard, Darlaston	—
8 " "	Darlaston	54	Price, West Bromwich	—
8 " "	ditto	54	ditto. ditto.	+*
8 " "	ditto	47	Lichfield Brewery Company	+
8 " "	ditto	56	Pritchard, Darlaston	—
8 " "	Willenhall	1	Manchester Brewery Company	—
8 " "	ditto	67	Home Brewed, "Old Oak," Willenhall	—
8 " "	ditto	68	Hamilton, Day & Co. (?)	—
9 " "	Stone (Rural)	29	Home Brewed, "Wharf Inn," Shebdon	—
9 " "	Gnosall (Rural)	30	Potts & Co. (?)	—
9 " "	ditto	31	Home-Brewed, "Junction Inn," Norbury	—
9 " "	ditto	32	Home-Brewed, "Cock Inn," Woodseaves	—
10 " "	Stone (Rural)	33	Dix & Co., Hanley	—
10 " "	ditto	16	Eley's Stafford Brewery	—
10 " "	Gnosall (Rural)	34	Home-Brewed, Whitehouse, Innkeeper	—
10 " "	ditto	35	Newport Brewery Company	+
10 " "	ditto	36	Wrekin Brewery Company	—
10 " "	ditto	37	Parton, Great Chatwell, H.B.	—
10 " "	ditto	38	Baker, Great Chatwell, H.B.	—
10 " "	ditto	39	Shifnal Brewery Company	—
10 " "	Wednesfield	1	Manchester Brewery Company	—
10 " "	ditto	19	Showell's, Oldbury	—
10 " "	Cannock (Rural)	69	Bloxwich Brewery Company	—
10 " "	Walsall (Rural)	47	Lichfield Brewery Company	+*
10 " "	ditto	3	Joule & Son, Stone	+*
10 " "	ditto	70	Roberts', Brownhills	—
10 " "	Tamworth	71	Lichfield City Brewery Company	—
10 " "	ditto	72	Smith, Aston	—
10 " "	Tamworth (Rural)	73	Eadie & Co., Burton	—
10 " "	Cannock (Rural)	87	South Stafford Brewery Company	—
11 " "	Wednesbury	74	Home Brewed, "Royal Exchange"	—
11 " "	ditto	75	ditto "Robin Hood"	—
11 " "	ditto	76	Well Head Brewery Company, Perry Barr	—
11 " "	ditto	54	Price, West Bromwich	—
11 " "	ditto	77	Home Brewed, "Park Inn"	—
11 " "	ditto	8	P. Walker, Burton	—
11 " "	ditto	78	Bates, West Bromwich	+*
11 " "	ditto	79	Homed Brewed, "Rising Sun"	—
12 " "	Lichfield (Rural)	80	Cooper & Co., Burton	—
12 " "	Wolstanton (Rural)	40	Hedge & Co., Stoke	—
13 " "	Longton	41	Steele, Market Drayton	—
13 " "	Stafford	42	Home Brewed, "Angel Inn"	—
13 " "	ditto	43	ditto "Waggon and Horses"	—
13 " "	ditto	44	ditto "Prince Albert"	—
13 " "	ditto	45	ditto "Princess Royal"	—
13 " "	ditto	46	ditto "Maltster's Arms"	—
13 " "	ditto	47	Lichfield Brewery Company	+
13 " "	ditto	48	Home Brewed, "Star and Garter"	—
14 " "	ditto	49	ditto "Castle Inn"	—
14 " "	ditto	50	Butler & Co., Wolverhampton	—
14 " "	Wolstanton (Rural)	6	Parker's, Burslem	+*
14 " "	ditto	6	Parker's, Burslem	+*
14 " "	Stoke-on-Trent	3	Joule and Son, Stone	+*
15 " "	Wednesbury	56	Pritchard, Darlaston	—
15 " "	ditto	81	Yardley & Co., Wolverhampton	—
15 " "	ditto	54	Price, West Bromwich	—
17 " "	Seisdon (Rural)	82	Rollaston, Niterton	—
17 " "	ditto	61	North Worcestershire Company	—
17 " "	ditto	83	Hanson, Dudley	—
17 " "	ditto	84	Home Brewed, "Elm Tree Inn," Kinver	—
17 " "	ditto	85	Flower and Sons, Stratford	—
17 " "	ditto	20	Burton Brewery Company	—
20 " "	Newcastle (Rural)	19	Showell's, Stoke	—
21 " "	Stone (Rural)	5	Bent's, Stone	—
21 " "	Willenhall	86	Home Brewed, "Tumbledown Bridge," Willenhall.	—

* Very minute trace.

II.—Detailed List of Breweries whose Beer was Analysed—*continued.*

Appendix No. 8.

Second Inquiry.—January and February 1901.

Date of Collection.	Sanitary District.	Brewery.		Arsenic Present, Positive or Negative.
		Distinctive Number.	Name.	
17 January 1901	Quarry Bank	–	Home Brewed, "New Inn"	—
17 „ „	ditto	–	ditto "White Horse"	—
17 „ „	ditto	–	Nock, Quarry Bank	—
7 February „	Wolstanton (Rural)	6	Parker's, Burslem	—
7 „ „	ditto	6	ditto	—
7 „ „	Longton	1	Manchester Brewery Company	—
7 „ „	ditto	3	Joule and Son, Stone	—
7 „ „	Fenton	4	Ridgway & Co., Newcastle	—
7 „ „	Stoke-on-Trent	3	Joule and Son, Stone	—
7 „ „	ditto	6	Parker's, Burslem	—
7 „ „	Stone	3	Joule and Son, Stone	—
8 „ „	Gnosall (Rural)	35	Newport Brewery Company	—
8 „ „	Stafford	?	?	
8 „ „	Cheadle (Rural)	3	Joule and Son, Stone	—
8 „ „	ditto	21	Bell & Co., Burton	—
11 „ „	Darlaston	47	Lichfield Brewery Company, Limited	—
11 „ „	Wednesbury	54	A. J. Price, West Bromwich	—
11 „ „	ditto	56	Pritchard, Darlaston	—
11 „ „	ditto	78	Bates, Sponwell Brewery	—
11 „ „	ditto	47	Lichfield Brewery Company, Limited	—
13 „ „	Blore Heath (Rural)	27	Pearce & Co., Market Drayton	—
13 „ „	Gnosall (Rural)	28	Wright & Co., Market Drayton	—
14 „ „	Blore Heath (Rural)	28	ditto ditto	—
14 „ „	ditto	27	Pearce & Co., Market Drayton	—
14 „ „	ditto	28	Wright & Co., Market Drayton	—
14 „ „	Newcastle (Rural)	26	Market Drayton Brewery Company	—
14 „ „	ditto	3	Joule and Son, Stone	—
17 „ „	Cheadle (Rural)	3	ditto ditto	—
18 „ „	Stafford	47	Lichfield Brewery Company, Limited	—
18 „ „	ditto	47	ditto ditto	—
18 „ „	Sedgley	–	Home Brewed, "Limerick," Gornall	—
18 „ „	ditto	52	Wolverhampton and Dudley Brewery Company.	—
18 „ „	ditto	–	Atkinson, Aston Park Brewery	—
18 „ „	Coseley	52	Wolverhampton and Dudley Brewery Company.	—
18 „ „	Bilston	83	Hanson and Sons, Dudley	—
19 „ „	Wolstanton (Rural)	4	Ridgway & Co., Newcastle	—
19 „ „	ditto	4	ditto ditto	—
19 „ „	Stoke-on-Trent	6	Parker's, Burslem	—
19 „ „	ditto	6	ditto	—
19 „ „	Longton	1	Manchester Brewery Company	—
19 „ „	Fenton	1	ditto ditto	—
20 „ „	Gnosall (Rural)	35	Newport Brewery Company	—
20 „ „	ditto	35	ditto ditto	—
23 „ „	Cannock (Rural)	88	Harper, Bilston	"An appreciable though not large amount."

III.—GLUCOSE SAMPLES ANALYSED.

Date of Collection.	Sanitary District.	Source from which obtained.		Arsenic Present, Positive or Negative.
		Distinctive Number.	Name.	
3 December 1900	Brownhills	92	Shire Oak Brewery	—
3 „ „	ditto	92	ditto	—
3 „ „	ditto	92	ditto	—
3 „ „	ditto	92	ditto	—
3 „ „	ditto	93	Hawthorn Inn, Walsall Wood	—
7 „ „	Lichfield	47	Lichfield Brewery Company	+
7 „ „	ditto	47	ditto ditto	—
7 „ „	ditto	47	ditto ditto	—
9 „ „	Newcastle	94	Butterworth, Newcastle	—
10 „ „	Bilston	88	Harper, Bilston	+
12 „ „	Newcastle	95	Hickman, Newcastle	—

Appendix No. 8.

IV.—SAMPLES OF CONFECTIONERY AND GOLDEN SYRUP ANALYSED.

Date of Collection.	District.	Nature of Sample.	From whom purchased.	Arsenic Present, Positive or Negative.
18 January 1901	Dracott-le-Moors	Confectionery	Henry Ridge	—
4 February "	Whiston	ditto	Charles Pattison	—
4 " "	Oakamoor	ditto	William Moseley	—
5 " "	Cobridge	Golden Syrup	John Draycott	—
5 " "	ditto	ditto	John Frearson	—
5 " "	ditto	ditto	ditto	—
5 " "	Burslem	ditto	Thomas William Berrisford	—
5 " "	ditto	ditto	Frederick Clarke	—
5 " "	ditto	Confectionery	Stephen Upton	—
5 " "	ditto	ditto	ditto	—
5 " "	ditto	ditto	Herbert Blaize	—
5 " "	ditto	ditto	ditto	—
5 " "	ditto	ditto	James Morton	—
5 " "	ditto	ditto	Eliza Wood	—
26 " "	Hixon	ditto	Catherine Murragh	—

Appendix No. 9.

APPENDIX No. 9.

TABLES handed in by Mr. *Estcourt*, showing results of EXAMINATION of certain SAMPLES submitted to him as Public Analyst.

I. SAMPLES other than Beer analysed for Arsenious Acid.

——	Mineral Waters.	Golden Syrup.	Sweets.	Jam.	Honey.
Received from Corporation of—					
Manchester - - - - - -	22	8	25	27	—
Oldham - - - - - -	—	—	—	4	6
Ashton-under-Lyne - - - -	12	—	3	1	—
Macclesfield, Bacup, and Lancaster	—	—	—	—	—

No trace of Arsenious Acid was found in any of the above samples.

A.—MANCHESTER.

II. SAMPLES of Beer examined for Arsenious Acid.

Five breweries, beer from each examined several days in November and December, 1900. Results in grains As_2O_3 per gallon.

——	November			December.										
	21	21	24	1	3	4	5	6	8	10	14	15	19	20
Brewery 1 - - - -	$\frac{1}{8}$	$\frac{1}{20}$	–	$\frac{1}{8}$	–	$\frac{1}{15}$	–	–	$\frac{1}{50}$	$\frac{1}{100}$ $\frac{1}{100}$ $\frac{1}{100}$	$\frac{1}{100}$	–	–	–
„ 2 - - - -	$\frac{1}{5}$	$\frac{1}{4}$	–	–	$\frac{1}{8}$	–	–	$\frac{1}{8}$	–	–	–	–	$\frac{1}{20}$	–
„ 3 - - - -	$\frac{1}{5}$	$\frac{1}{12}$	–	–	–	–	–	$\frac{1}{200}$	–	–	–	–	–	–
„ 4 - - - -	$\frac{1}{8}$	$\frac{1}{20}$	–	$\frac{1}{8}$ $\frac{1}{15}$	–	–	$\frac{1}{8}$	$\frac{1}{20}$	–	$\frac{1}{100}$	–	–	–	–
„ 5 - - - -	–	–	$\frac{11}{100}$	$\frac{1}{8}$	–	–	–	–	–	$\frac{1}{100}$ and $\frac{1}{50}$	–	–	–	–

Other 45 Breweries, Beer from each examined occasionally in November and December, 1900. Results in grains As_2O_3 per gallon.

Brewery Number.	Date of collection of Sample.	Grains Arsenic per gallon.	Brewery Number.	Date of collection of Sample.	Grains Arsenic per gallon.
6	Nov. 21	$\frac{1}{100}$	28	Jan. 16 or 18	0
6	„ 24	$\frac{1}{200}$	29	„ 16 or 18	0
7	„ 21	$\frac{1}{50}$	30	„ 16 or 18	0
7	„ 24	0	31	„ 16 or 18	0
8	„ 21 & 24	0	32	„ 16 or 18	0
9	„ 21 & 24	0	33	„ 18	0
10	„ 21 & 24	0	34	„ 18	0
11	„ 21 & 24	0	35	„ 18	$\frac{1}{100}$
12	„ 21 & 24	0	36	„ 18	0
13	„ 21 & 24	0	37	„ 18	0
14	„ 21 & 24	0	38	„ 22 or 24	0
15	Dec. 14	$\frac{1}{100}$	39	„ 22 or 24	0
16	„ 14	$\frac{1}{100}$	40	„ 22 or 24	0
17	„ 14	$\frac{1}{100}$	41	„ 22 or 24	0
18	„ 14	$\frac{1}{100}$	42	„ 24	0
19	„ 14	$\frac{1}{100}$	43	„ 24	0
20	„ 14	$\frac{1}{100}$	44	„ 24	0
21	„ 14	$\frac{1}{100}$	45	Feb. 1	$\frac{1}{100}$
22	„ 14	$\frac{1}{100}$	46	„ 1	$\frac{1}{100}$
23	„ 14	$\frac{1}{100}$	47	„ 6	0
24	Jan. 16 or 18	0	48	„ 6	0
25	„ 16 or 18	$\frac{1}{50}$	49	„ 14	0
26	„ 16 or 18	$\frac{1}{100}$	50	„ 14	$\frac{1}{200}$
27	„ 16 or 18	$\frac{1}{100}$			

Appendix No. 9.

SUMMARY of Above:—Results of Analyses of 81 Samples of Beer brewed by 50 Brewers.

No. of Samples.	Amount of As_2O_3 per gallon.
1	$\frac{1}{10}$
10	$\frac{1}{8}$
1	$\frac{1}{6}$
1	$\frac{1}{5}$
2	$\frac{1}{4}$
1	$\frac{1}{3}$
2	$\frac{1}{2}$
8	$\frac{1}{30}$
22	$\frac{1}{100}$
5	$\frac{1}{200}$
28	0

21 brewers of Arsenicated Beer: 19 less than $\frac{1}{20}$ grain, 5 not more than $\frac{1}{4}$.

B.—ASHTON UNDER LYNE CORPORATION.

SAMPLES analysed from 26th November to 4th February.

No. of Samples of Beer.	Amount of As_2O_3 per gallon.	No. of Samples of		
1	$\frac{1}{4}$ grain	Mineral Waters	12	No. As_2O_3
2	$\frac{1}{6}$ "	Sweets	3	"
1	$\frac{1}{10}$ "	Jam	1	"
1	$\frac{1}{12}$ "			
6	$\frac{1}{15}$ "			
1	$\frac{1}{20}$ "			
2	$\frac{1}{30}$ "			
8	$\frac{1}{100}$ "			
1	$\frac{1}{200}$ "			
17	0			
Total 49				

C.—MACCLESFIELD CORPORATION.

SAMPLES of Beer analysed from 28th November to 21st December.

No. of Samples.	Amount of As_2O_3 per gallon.
1	$\frac{1}{10}$ grain
2	$\frac{1}{30}$ "
3	$\frac{1}{100}$ "
7	$\frac{1}{200}$ "
11	0
Total 24	

D.—LANCASTER CORPORATION.

SAMPLES of Beer analysed from 6th December to 12th December.

No. of Samples.	Amount of As_2O_3 per gallon.
1	$\frac{1}{4}$ grain
1	$\frac{1}{6}$ "
2	$\frac{1}{15}$ "
2	$\frac{1}{30}$ "
8	$\frac{1}{200}$ "
8	0
Total 22	

E.—BACUP CORPORATION.

Appendix No. 9

SAMPLES of Beer analysed from 11th December to 16th January.

No. of Samples.	Amount of As_2O_3 per gallon.
3	$\frac{1}{20}$
7	$\frac{1}{100}$
8	0
Total 18	

III.—BREWERS' SAMPLES.

RESULTS of Analyses of following samples received from 26th November to 16th January, from Brewers in Manchester and neighbourhood.

31 Brewers delivered 195 samples of Beer :

104 samples were genuine.

91 contained As_2O_3 from $\frac{1}{4}$ to $\frac{1}{200}$ of a grain per gallon.

41 samples of Glucose and Invert Sugar were received :

21 were genuine.

20 contained As_2O_3 from ·005 to ·03 per cent.

74 samples of Malt were received :

17 were genuine.

57 contained As_2O_3 from $\frac{1}{2}$ to $\frac{1}{100}$ of a grain in 40 ounces.

[*N.B.*—40 ounces of Malt represent 1 gallon of Beer.]

Appendix No. 10.

APPENDIX No. 10.

TABLES handed in by Mr. *Edward Sergeant*.

COUNTY PALATINE OF LANCASTER.

TABLE I.

LIST of SAMPLES of BEER (including Ales, Stouts, &c.) purchased for analysis between 27th November 1900, and 28th February 1901, by the County Police acting on the instructions of the County Medical Officer of Health. For Summary *see* Table II.

(*Note.*—Samples purchased prior to 4th December were "preliminary" samples, and not followed by legal proceedings).

Sample Number and Police Division.	Date of Purchase.	Sanitary District.	House "tied" or "free."	Price of beer per quart.	Brewery Distinctive Number.	Result of Analysis (*See* foot note.)	Remarks.
	1900:			d.			
84 SD	27 Nov.	Waterloo-with-Seaforth	Tied	5	27	*c*	
85 „	„	„	„	5	152	*c*	
86 „	„	„	„	5	28	*a*	
87 „	„	„	„	5	89	*a*	
88 „	„	Litherland	„	5	30	*a*	
89 „	„	„	„	5	153	*c*	
90 „	„	„	„	5	84	*c*	
481 PD	„	Huyton-with-Roby	„	5	32	*a*	
482 „	„	Prescot	„	5	71	*a*	
483 „	„	„	„	5	162	*a*	
484 „	„	„	„	5	27	*a*	
485 „	„	„	„	5	72	*a*	
486 „	„	„	„	5	92	*a*	
487 „	„	„	„	5	62	*a*	
280 Ws D	„	Whiston (Rural)	„	6	71	*a*	
281 „	„	„	„	6	45	*a*	
282 „	„	„	„	6	46	*a*	
283 „	„	Widnes (Borough)	„	6	72	*a*	
284 „	„	„	„	6	168	*a*	
285 „	„	„	„	6	162	*a*	
286 „	„	„	„	6	33	*b*	
287 „	„	„	„	6	92	*a*	
183 WD	„	Leigh (Borough)	„	5	6	*a*	
184 „	„	„	„	5	33	*a*	
66 Wgn D	„	Ashton-in-Makerfield	„	5	4	*c*	
67 „	„	„	„	5	71	*a*	
68 „	„	„	„	5	63	*a*	
688 By D.	28 Nov.	Ramsbottom	„	4	23	*a*	
689 „	„	„	„	6	43	*a*	
823 MD	„	Moss Side	„	4	105	*a*	
824 „	„	„	„	4	97	*a*	
825 „	„	„	„	4	86	*a*	
826 „	„	„	„	6	154	*c*	
827 „	„	„	„	4	87	*a*	
828 „	„	Stretford	„	4	162	*a*	
829 „	„	„	„	4	69	*a*	
830 „	„	Moss Side	„	4	163	*a*	
646 OD	„	Ormskirk	„	5	56	*a*	
647 „	„	„	„	7	56	*a*	
648 „	„	„	„	5	153	*c*	
649 „	„	„	„	7	153	*a*	
185 WD	„	Newton-in-Makerfield	„	5	169	*a*	
186 „	„	„	„	5	71	*a*	
187 „	„	„	Free	5	36	*a*	
188 „	„	Warrington (Rural)	Tied	5	63	*b*	
69 Wgn D	„	Hindley	„	4	156	*a*	
70 „	„	Ince-in-Makerfield	„	4	111	*a*	
71 „	„	„	„	4	118	*c*	
72 „	„	„	„	4	141	*a*	
60 HBD	29 Nov.	Nelson (Borough)	„	5	94	*c*	
61 „	„	„	„	4½	133	*c*	
62 „	„	„	„	5	3	*a*	
691 By D	„	Radcliffe	„	4	51	*c*	
694 „	„	Heywood (Borough)	„	4	121	*a*	
91 SD	„	Litherland	„	5	27	*c*	
92 „	„	Waterloo-with-Seaforth	„	5	152	*b*	
93 „	„	Litherland	„	5	153	*c*	
224 Km D	30 Nov	Kirkham	„	4	38	*c*	
1450 Rs D	„	Rawtenstall (Borough)	„	3	17	*a*	

(*a*) Genuine, or free from arsenic.
(*b*) Slightly arsenicated but passable.
(*c*) Containing quantity of arsenic injurious to health.

List of Samples of Beer (including Ales, Stouts, &c.)—*continued.*

Appendix No. 10.

Sample Number and Police Division.	Date of Purchase.	Sanitary District.	House "tied" or "free."	Price of beer per quart.	Brewery Distinctive Number.	Result of Analysis. (*See* foot note.)	Remarks.
	1900:			*d*			
313 LD	30 Nov.	Standish-with-Langtree	Tied	5	4	*c*	
94 SD	„	Litherland	„	5	84	*a*	
95 „	„	Waterloo-with-Seaforth	„	5	153	*c*	
190 WD	„	Leigh (Borough)	„	6	33	*a*	
73 Wgn D	„	Hindley	„	5	156	*a*	
1340 RD	1 Dec.	Chadderton	„	5	102	*a*	
838 MD	„	Moss Side	„	6	154	*a*	
82 NLD	3 Dec.	Dalton-in-Furness	„	6	73	*b*	
83 „	„	„	„	6	73	*b*	
317 LD	„	Chorley (Borough)	„	—	78	*a*	
318 „	„	„	„	—	149	*c*	
839 MD	„	Eccles (Borough)	„	4	170	*a*	
840 „	„	„	„	4	88	*a*	
841 „	„	„	„	4	123	*a*	
488 PD	„	Prescot	„	5	46	*a*	
191 WD	„	Warrington (Rural)	„	5	63	*c*	
84 NLD	4 Dec.	Dalton-in Furness	„	6	49	*a*	
85 „	„	„	„	5	37	*c*	Report received too late for prosecution.
86 „	„	„	„	6	73	*b*	
87 „	„	„	„	5	74	*b*	
89 „	„	Ulverston	Brewery	—	73	*b*	
63 HBD	„	Colne (Borough)	Tied	5	59	*c* ¾ grain per gal.	Prosecution. Fined 20*s.* and costs.
1451 Rs D	„	Rawtenstall (Borough)	„	3	98	*a*	
1452 „	„	„	„	3	147	*a*	
871 Bn D	„	Little Lever	„	4	82	*c* ¼th grain per gal.	Prosecution withdrawn after fine inflicted sample No. 872.
872 „	„	„	„	6	82	*c* ¾th grain per gal.	Prosecution. Fined 5*l.* and costs.
873 „	„	Kearsley	„	4	69	*c* ¼th grain per gal.	Prosecution. Fined 5*l.* and costs.
874 „	„	„	„	6	69	*b*	
842 MD	„	Withington	„	4	109	*a*	
843 „	„	„	Free	4	69	*a*	
844 „	„	„	Tied	4	87	*a*	
650 OD	„	Ormskirk	„	7	153	*a*	
651 „	„	„	„	5	153	*c* ¼th grain per gal.	Prosecution. Fined 5*l.* and costs.
652 „	„	„	„	7	31	*a*	
653 „	„	„	„	5	31	*a*	
654 „	„	„	„	7	31	*a*	
655 „	„	Lathom and Burscough	„	7	153	*a*	
656 „	„	„	„	5	153	*c* ¼th grain per gal.	Prosecution. Case adjourned pending decision of higher court.
657 „	„	Birkdale	„	7	138	*a*	
658 „	„	„	„	5	138	*a*	
659 „	„	„	„	7	158	*a*	
660 „	„	„	„	5	158	*a*	
700 By D	5 Dec.	Heywood (Borough)	„	4	102	*a*	
701 „	„	„	„	4	123	*a*	
702 „	„	„	„	4	121	*b*	
846 MD	„	Swinton and Pendlebury	„	4	171	*c*	No prosecution. Sample obtained from sealed barrel at request of Analyst.
847 „	„	„	„	4	123	*a*	
848 „	„	„	„	4	136	*c* ¼th grain per gal.	Prosecution. Dismissed on grounds that summons issued under wrong section. Appeal pending.
849 „	„	„	„	3	142	*b*	
1453 Rs D	6 Dec.	Haslingden (Borough)	„	3	148	*a*	
1454 „	„	„	„	3	113	*a*	
1455 „	„	„	„	3	67	*b*	
225 Km D	7 Dec.	Kirkham	„	4	14	*a*	
226 „	„	„	„	4	158	*a*	
227 „	„	„	„	4	161	*c* ⅓rd grain per gal.	Prosecution. Fined 5*l.* and costs.
228 „	„	„	„	4	13	*a*	
876 Bn D	„	Westhoughton	„	4	83	*a*	
877 „	„	„	„	6	83	*a*	
879 „	„	Aspull	Free	6	91	*a*	
880 „	„	„	„	6	91	*a*	

(*a*)—Genuine, or free from arsenic.
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Appendix No. 10.

List of Samples of Beer (including Ales, Stouts, &c.)—*continued.*

Sample Number and Police Division.	Date of Purchase.	Sanitary District.	House "tied" or "free."	Price of beer per quart.	Brewery Distinctive Number.	Result of Analysis. (*See* foot note.)	Remarks.
	1900 :			*d*			
1353 RD	7 Dec.	Middleton (Borough)	Tied	4	55	*c* ¼th grain per gal.	Prosecution. Adjourned pending decision of higher court.
297 SLD	8 Dec.	Morecambe	,,	5	174	*a*	
298 ,,	,,	,,	,,	5	175	*a*	
299 ,,	,,	,,	,,	5	106	*a*	
850 MD	,,	Reddish	,,	4	145	*a*	
851 ,,	,,	Eccles (Borough)	,,	4	10	*a*	
852 ,,	,,	Reddish	,,	4	35	*a*	
853 ,,	,,	,,	,,	4	97	*a*	
64 HBD	10 Dec.	Padiham	,,	5	41	*b*	
65 ,,	,,	,,	,,	5	148	*a*	
854 MD	,,	Eccles (Borough)	,,	4	14	*a*	
855 ,,	,,	,,	,,	4	163	*c* ¼th grain per gal.	Prosecution. Fined £5 and costs. Appeal pending.
856	,,	,,	,,	4	86	*a*	
857	,,	,,	,,	4	172	*a*	
858	,,	,,	,,	4	145	*b*	
859 ,,	,,	,,	Free	4	115	*a*	
860 ,,	,,	,,	,,	4	44	*a*	
861 ,,	,,	,,	Tied	4	100	*a*	
862 ,,	,,	,,	,,	4	69	*b*	
66 HBD	11 Dec.	Nelson (Borough)	,,	5	80	*a*	
67 ,,	,,	,,	,,	5	3	*a*	
68 ,,	,,	,,	,,	4½	133	*c* ¼th grain per gal.	Prosecution. Fined £3 and costs.
69 ,,	,,	,,	,,	5	94	*a*	
70 ,,	,,	,,	,,	5	68	*b*	
914 Ac D	,,	Clitheroe (Borough)	,,	2½	81	*a*	
915 ,,	,,	,,	,,	3½	81	*a*	
1456 Rs D	,,	Rawtenstall (Borough)	,,	3	3	*a*	
1457 ,,	,,	,,	,,	3	95	*a*	
1458 ,,	,,	,,	,,	3	107	*b*	
1459 ,,	,,	,,	,,	3	18	*b*	
84 Wgn D	12 Dec.	Upholland	,,	5	68	*a*	
85 ,,	,,	,,	,,	5	69	*a*	
86 ,,	,,	,,	,,	5	64	*a*	
87 ,,	,,	Orrell	,,	5	2	*a*	
88 ,,	,,	,,	,,	5	7	*a*	
89 ,,	,,	Pemberton	,,	4	8	*a*	
703 By D	13 Dec.	Ramsbottom	Free	4	69	*a*	
704 ,,	,,	,,	Tied	4	67	*c* ¼th grain per gal.	Prosecution dismissed on the ground that analyst's certificate was insufficient. Appeal pending.
705 ,,	,,	Radcliffe	Free	6	163	*a*	
706 ,,	,,	,,	Tied	4	42	*c* ¼th grain per gal.	Prosecution. Fined 20*s.* and costs.
850 GD	14 Dec.	Garstang (Rural)	,,	5	174	*b*	
851 ,,	,,	,,	,,	5	160	*c* ⅓rds grain per gal.	Prosecution. Fined 20*s.* and costs.
863 MD	,,	Gorton	,,	6	173	*a*	
864 ,,	,,	,,	,,	4	155	*a*	
865 ,,	,,	,,	,,	4	143	*b*	
866 ,,	,,	,,	,,	4	14	*a*	
867 ,,	,,	Levenshulme	,,	5	144	*b*	
868 ,,	,,	,,	,,	4	47	*a*	
869 ,,	,,	,,	,,	4	163	*a*	
870 ,,	,,	,,	,,	4	44	*a*	
871 ,,	15 Dec.	Eccles (Borough)	,,	4	162	*a*	
872 ,,	,,	,,	,,	4	142	*b*	
873 ,,	,,	,,	,,	4	97	*a*	
874 ,,	,,	,,	Free	4	66	*b*	
875 ,,	,,	,,	Tied	4	117	*a*	
876 ,,	,,	,,	Free	6	48	*a*	
707 By D	17 Dec.	Heywood (Borough)	Tied	7	121	*a*	
708 ,,	,,	,,	,,	7	121	*a*	
709 ,,	,,	,,	,,	7	121	*a*	
852 GD	18 Dec.	Garstang (Rural)	Free	5	106	*a*	
853 ,,	,,	,,	,,	5	161	*c* ½ grain per gal.	Prosecution. Fined 20*s.* and costs.
854 ,,	,,	,,	Tied	5	159	*a*	
855 ,,	,,	,,	Free	5	175	*a*	
192 WD	,,	Leigh (Borough)	Tied	5	44	*b*	
193 ,,	,,	,,	,,	5	42	*a*	

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(*c*)—Containing quantity of arsenic injurious to health.

List of Samples of Beer (including Ales, Stouts, &c.)—*continued.*

Appendix No. 10.

Sample Number and Police Division.	Date of Purchase.	Sanitary District.	House "tied" or "free."	Price of beer per quart.	Brewery Distinctive Number.	Result of Analysis. (*See* foot note.)	Remarks.
	1900:			*d.*			
1354 RD	20 Dec.	Littleborough	Tied	4	26	*c* ¼th grain per gal.	Prosecution. Sample sent to Somerset House. Case dismissed on technical point.
1355 „	„	„	„	4	44	*a*	
1356 „	„	„	„	4	117	*a*	
1357 „	„	Whitworth	„	4	23	*a*	
1358 „	„	„	„	4	121	*a*	
1359 „	„	„	Free	4	98	*a*	
71 HBD	22 Dec.	Nelson (Borough)	Tied	3	133	*c* ½ grain per gal.	Prosecution. Fined 3*l.* and costs.
	1901:						
856 GD	1 Jan.	Garstang (Rural)	„	5	160	*c* ¼th grain per gal.	No prosecution. Sample taken from a sealed barrel.
857 „	2 Jan.	Fulwood	„	4	13	*a*	
858 „	„	„	„	4	14	*c* $\frac{1}{10}$th grain per gal.	Prosecution pending.
859 „	„	„	„	4	13	*a*	
877 MD	„	Urmston	„	4	69	*b*	
878 „	„	„	„	6	2	*b*	
879 „	„	„	„	4	145	*b*	
880 „	„	„	„	4	154	*b*	
96 SD	3 Jan.	Waterloo-with-Seaforth	Free	5	53	*a*	
97 „	„	Crosby	Tied	5	45	*a*	
98 „	„	Waterloo-with-Seaforth	„	5	30	*a*	
99 „	„	„	„	5	159	*a*	
229 Km D	4 Jan.	Fleetwood	„	5	39	*a*	
230 „	„	„	„	5	162	*a*	
231 „	„	„	„	5	145	*a*	
232 „	„	„	Free	6	50	*a*	
300 SLD	7 Jan.	Lancaster (Rural)	Tied	5	14	*b*	
301 „	„	„	Free	6	93	*b*	
302 „	„	Morecambe	Tied	5	150	*b*	
303 „	„	„	„	5	14	*b*	
233 Km D	„	Preston (Rural)	Free	5	160	*c* ¼th grain per gal.	Prosecution. Fined 40*s.* costs.
234 „	„	Kirkham	„	4	161	*b*	
320 LD	„	Preston (Rural)	„	4	79	*b*	
860 GD	8 Jan.	Garstang (Rural)	Tied	5	160	*c* $\frac{1}{10}$th grain per gal.	Prosecution Fined 20*s.* and and costs.
861 „	„	Preston (Rural)	Free	4	113	*c* $\frac{1}{10}$th grain per gal.	Prosecution. Fined 40*s.* and costs.
321 LD	„	Chorley (Borough)	Tied	4	160	*b*	
882 Bn D	„	Turton	„	4	82	*a*	
883 „	„	„	„	6	82	*a*	
884 „	„	„	„	4	135	*a*	
885 „	„	„	„	6	135	*a*	
661 OD	9 Jan.	Ormskirk	„	5	56	*a*	
662 „	„	„	„	7	56	*a*	
663 „	„	„	„	5	153	*a*	
664 „	„	„	„	7	153	*a*	
665 „	„	West Lancashire (Rural)	„	5	70	*a*	
666 „	„	„	„	7	70	*a*	
90 NLD	10 Jan.	Ulverston (Rural)	Free	5	93	*a*	
91 „	„	„	„	5	101	*a*	
92 „	„	„	„	5	57	*a*	
93 „	„	„	„	5	125	*a*	
94 „	„	„	Tied	5	1	*a*	
95 „	„	„	Free	5	73	*a*	
96 „	„	„	Tied	6	11	*a*	
97 „	„	Grange	Free	6	157	*a*	
98 „	„	„	Tied	5	126	*a*	
304 SLD	„	Morecambe	„	5	113	*a*	
305 „	„	„	Free	5	151	*a*	
306 „	„	„	Tied	5	148	*a*	
862 GD	„	Garstang (Rural)	„	5	174	*a*	
863 „	„	„	Free	5	175	*a*	
881 MD	„	Swinton and Pendlebury	„	4	171	*c* ¼th grain per gal.	Prosecution. Adjourned pending decision of higher Court.
882 „	„	„	Tied	4	88	*b*	
883 „	„	„	„	4	69	*b*	
884 „	„	„	„	3	142	*c* ½th grain per gal.	Prosecution. Adjourned pending decision of higher Court.
710 By D	14 Jan.	Heywood (Borough)	„	6	24	*a*	

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(*c*)—Containing quantity of arsenic injurious to health.

Appendix No. 10.

List of Samples of Beer (including Ales, Stouts, &c.)—*continued.*

Sample Number and Police Division.	Date of Purchase.	Sanitary District.	House "tied" or "free."	Price of beer per quart.	Brewery Distinctive Number.	Result of Analysis. (*See* footnote.)	Remarks.
	1901:			*d.*			
711 By D	14 Jan.	Heywood (Borough)	Tied	4	121	*c* 1/4th grain per gal.	Prosecution. Fined 40*s.* and costs.
712 „	„	Radcliffe	„	4	51	*a*	
713 „	„	„	„	4	52	*a*	
892 Bn D	16 Jan.	Horwich	„	6	145	*a*	
893 „	„	„	„	6	54	*a*	
100 SD	„	Litherland	„	5	28	*b*	
90 Wgn D	„	Hindley	„	5	32	*a*	
91 „	„	Ashton-in-Makerfield	„	5	4	*a*	
92 „	„	Golborne	„	5	72	*a*	
93 „	„	„	„	5	63	*a*	
94 „	„	„	„	5	118	*a*	
95 „	„	„	„	7	33	*a*	
307 SL D	17 Jan.	Heysham	„	5	125	*a*	
308 „	„	„	„	5	116	*a*	
309 „	„	Morecambe	Free	5	132	*a*	
239 Km D	„	Fleetwood	„	6	58	*a*	
240 „	„	„	„	5	158	*a*	
241 „	„	Kirkham	Tied	4	38	*b*	
242 „	„	Fylde (Rural)	Free	5	89	*a*	
492 PD	„	Rainford	Tied	5	56	*a*	
493 „	„	„	„	5	153	*a*	
494 „	„	Whiston (Rural)	Free	5	62	*a*	
1360 RD	19 Jan.	Littleborough	Tied	4	28	*a*	
1363 „	„	„	„	4	26	*a*	
1364 „	„	„	„	6	26	*a*	
864 GD	21 Jan.	Fulwood	„	4	14	*a*	
865 „	„	Preston (Rural)	Free	4	75	*a*	
866 „	„	Garstang (Rural)	„	5	161	*a*	
867 „	„	„	Tied	5	38	*a*	
288 Ws D	23 Jan.	Garston	„	6	139	*a*	
289 „	„	„	„	6	92	*a*	
290 „	„	„	„	6	28	*a*	
291 „	„	„	„	6	140	*a*	
292 „	„	„	„	6	27	*a*	
904 LBD	24 Jan.	Walton-le-Dale	Free	4	119	*a*	
293 Ws D	„	Garston	Tied	6	124	*a*	
294 „	„	„	„	6	153	*a*	
295 „	„	„	„	6	152	*a*	
868 GD	28 Jan.	Garstang (Rural)	„	5	113	*a*	
869 „	„	Preston (Rural)	Free	4	113	*a*	
247 Km D	„	„	„	5	16	*a*	
248 „	„	„	Tied	5	14	*a*	
249 „	„	Fylde (Rural)	„	5	50	*a*	
250 „	„	Preston (Rural)	„	4	160	*b*	
79 HBD	„	Padiham	„	5	134	*a*	
80 „	„	„	„	5	107	*a*	
871 GD	4 Feb.	Garstang (Rural)	Free	5	15	*a*	
873 „	„	„	„	5	76	*a*	
728 By D	6 Feb.	Whitefield	Tied	4	22	*a*	
729 „	„	„	„	6	136	*a*	
730 „	„	„	„	4	97	*a*	
731 „	„	„	„	6	109	*a*	
324 LD	7 Feb.	Chorley (Borough)	„	4	15	*a*	
325 „	„	„	„	4	5	*a*	
253 Km D	11 Feb.	Lytham	Free	5	159	*a*	
254 „	„	„	Tied	5	163	*a*	
255 „	„	„	Free	5	2	*a*	
256 „	„	„	„	5	164	*a*	
732 By D	„	Heywood (Borough)	Tied	4	25	*a*	
733 „	„	„	„	6	43	*b*	
734 „	„	„	Free	4	96	*b*	
735 „	„	„	Tied	4	43	*b*	
736 „	18 Feb.	Radcliffe	„	6	150	*a*	
737 „	„	„	„	4	145	*a*	
738 „	„	Heywood (Borough)	„	4	137	*a*	
739 „	„	„	„	4	166	*a*	
899 Bn D	19 Feb.	Little Hulton	Free	4	165	*a*	
900 „	„	„	Tied	4	42	*a*	
877 GD	20 Feb.	Garstang (Rural)	Free	5	16	*a*	
879 „	„	„	„	5	77	*a*	
310 SLD	21 Feb.	Lancaster (Rural)	Tied	6	20	*b*	
313 „	„	„	„	5	21	*b*	
501 PD	„	Much Woolton	„	5	92	*a*	
502 „	„	„	Free	5	103	*a*	
503 „	„	„	Tied	5	89	*a*	
99 NLD	23 Feb.	Dalton-in-Furness	„	6	158	*a*	
100 „	„	„	„	5	74	*a*	
101 „	„	„	Free	7	93	*b*	
102 „	„	„	Tied	6	159	*a*	

(*a*)—Genuine, or free from arsenic.
(*b*)—Slightly arsenicated, but passable.
(*c*)—Containing quantity of arsenic injurious to health.

List of Samples of Beer (including Ales, Stouts, &c.—*continued.*

Appendix No. 10.

Sample Number and Police Division.	Date of Purchase.	Sanitary District.	House "tied" or "free."	Price of beer per quart.	Brewery Distinctive Number.	Result of Analysis. *See* foot note.	Remarks.
	1901:			d.			
103 NLD	23 Feb	Dalton-in-Furness	Free	5	127	*a*	
104 „	„	„	Tied	5	128	*a*	
105 „	„	Ulverston (Rural)	Free	6	99	*a*	
106 „	„	„	Tied	5	12	*a*	
107 „	„	Dalton-in-Furness	„	6	125	*a*	
108 „	„	Ulverston (Rural)	„	5	12	*a*	
257 Km D	25 Feb	Preston (Rural)	Free	4½	16	*a*	
258 „	„	„	„	5	77	*b*	
259 „	„	Fylde (Rural)	„	5	77	*a*	
260 „	„	„	„	5	77	*b*	
261 „	„	Kirkham	Tied	6	38	*b*	
262 „	„	„	„	6	161	*a*	
101 SD	„	Crosby	„	5	99	*b*	
102 „	„	„	„	5	162	*a*	
103 „	„	„	Free	5	153	*a*	
104 „	„	„	Tied	5	153	*a*	
96 Wgn D	„	Ince-in-Makerfield	„	4	104	*a*	
97 „	„	„	„	4	34	*a*	
98 „	„	„	„	4	112	*a*	
99 „	„	„	„	5	163	*a*	
100 „	„	„	„	5	9	*a*	
101 „	„	„	„	4	56	*a*	
88 HBD	27 Feb.	Colne (Borough)	Brewery	–	59	*a*	

(*a*) Genuine, or free from arsenic.
(*b*) Slightly arsenicated but passable.
(*c*) Containing quantity of arsenic injurious to health.

Appendix No. 10.

TABLE II.

COUNTY OF LANCASTER.

SUMMARY of Beer Samples Analysed and List of Samples of Glucose obtained by the County Police.

Police Division.	Total Samples obtained.	Beer.						Glucose and Invert Sugar.		
		Samples purchased.	Result of Analysis.			Legal proceedings instituted.		Samples obtained.	Result of Analysis.	
			Genuine or free from Arsenic.	Slightly Arsenicated but passable.	Containing quantity of Arsenic injurious to health.				Free from Arsenic.	Containing Arsenic.
Lonsdale North	30	26	19	6	1	–		4	4	–
Lonsdale South	15	15	9	6	–	–		–	–	–
Garstang	24	24	17	1	6	5		–	–	
Kirkham	29	29	20	6	3	2		–	–	–
Blackburn Lower	4	1	1	–	–	–		3	3	–
Blackburn Higher	15	15	7	3	5	3		–	–	–
Church	3	2	2	–	–	–		1	1	–
Rossendale	11	10	7	3	–	–		1	1	–
Leyland	21	7	3	2	2	–		14	14	–
Bolton	19	16	12	1	3	3		3	2	1
Bury	39	30	22	4	4	3		9	8	1
Rochdale	15	11	9	–	2	2		4	3	1
Ashton-under-Lyne.	–	–	–	–	–	–		–	–	–
Manchester	62	54	35	13	6	4		8	6	2
Seaforth	21	21	10	4	7	–		–	–	–
Ormskirk	23	21	18	–	3	–		2	1	1
Prescot	17	14	14	–	–	–		3	3	–
Widnes	16	16	15	1	–	–		–	–	–
Warrington	11	10	7	2	1	–		1	1	–
Wigan	33	26	24	–	2	–		7	6	1
Total	408	348	251	52	45	24		69	53	7

APPENDIX No. 11.

"Spot Map" of the Administrative County of Lancaster, showing distribution of cases of, and deaths by, Poisoning by Arsenic in Beer.

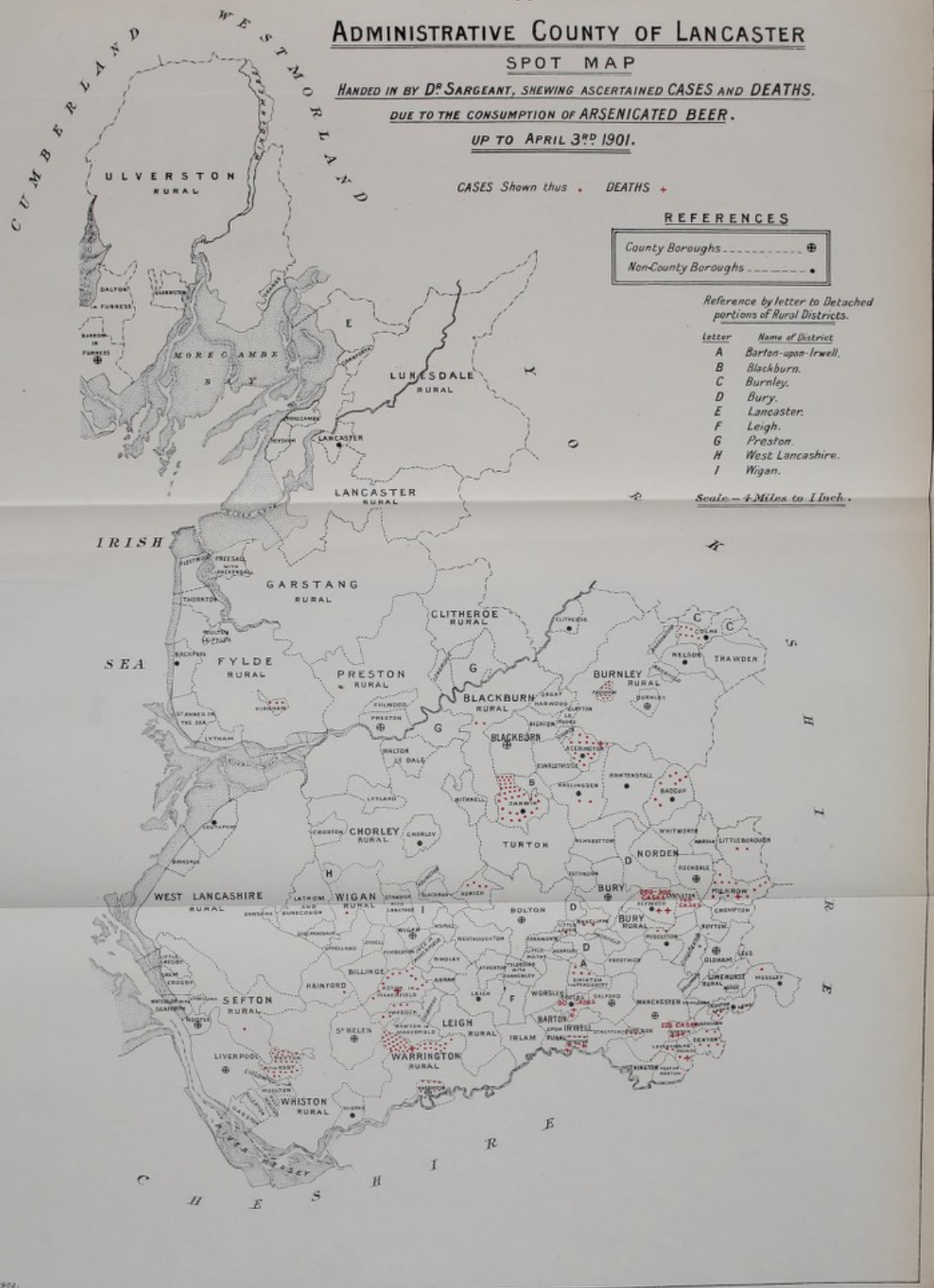
Appendix № II.

ADMINISTRATIVE COUNTY OF LANCASTER

SPOT MAP

HANDED IN BY Dr. SARGEANT, SHEWING ASCERTAINED CASES AND DEATHS.
DUE TO THE CONSUMPTION OF ARSENICATED BEER.
UP TO APRIL 3rd 1901.

CASES Shown thus . DEATHS +



REFERENCES

County Boroughs ..... ⊕
Non-County Boroughs ..... •

Reference by letter to Detached portions of Rural Districts.

Letter	Name of District
A	Barton-upon-Irwell.
B	Blackburn.
C	Burnley.
D	Bury.
E	Lancaster.
F	Leigh.
G	Preston.
H	West Lancashire.
I	Wigan.

Scale.—4 Miles to 1 Inch.

1965. 2. 1902.

Waller & Graham Ltd Litho London.

Appendix (No. 1.)

TABLE III.

ADMINISTRATIVE COUNTY OF LANCASTER.

List of Prosecutions *re* Arsenic in Beer,

—	No. of Sample.	Name of Vendor.	Price per quart.	Brewery Distinctive Number.	Date of Sample.
			d.		1900:
1	848	Ernest Ormerod, Duke of Wellington Inn, Bolton Road, Pendlebury.	4	136	5 December
2	871	Lawrence Halliwell, Grapes Inn, Little Lever.	4	82	4 December
3	872	Lawrence Halliwell, Grapes Inn, Little Lever	6	82	4 December
4	873	Samuel Wolstencroft, Man and Scythe Inn, Kearsley	4	69	4 December
5	227	Thomas Coupe, St. George's Hotel, Kirkham	4	161	7 December
6	1353	John Ed. Eastwood, Royal Oak Hotel, Bowlee, Middleton.	4	55	7 December
7	68	John Strickland, 1A, Russell Street, Nelson	4½	133	11 December
8	71	John Strickland, 1A, Russell Street, Nelson	3	133	22 December
9	855	Frank Lee, Stanley Arms, Liverpool Road, Eccles	4	163	10 December
10	704	John Greenhalgh, Printers' Arms, Stubbins Lane, Ramsbottom.	4	67	13 December
11	651	Thomas Holburt, Black Bear, Ormskirk	5	153	4 December
12	656	Alice Adair, Junction Hotel, Lathom	5	153	4 December
13	706	James Barlow, Crown Inn, Blackburn Street, Radcliffe	4	42	13 December
14	851	Thomas Hornby Richardson, Horns Inn, Garstang	5	160	14 December
15	853	William Gardner, Middle Holly Inn, Cabus, near Garstang.	5	161	18 December
16	63	Sarah Ann Storr, Derby Arms Hotel, Colne	5	59	4 December
17	1354	William Taylor, Dyers' Arms, Whitelees Road, Littleborough.	4	26	20 December
					1901:
18	858	Edward Hurling, Prince Albert Hotel, Fulwood	4	14	2 January
19	233	Peter Critchley, Saddle Inn, Lea	5	160	7 January
20	860	Thomas Metcalf, White Horse Inn, Myerscough	5	160	8 January
21	861	James Bell, Golden Ball, Broughton	4	113	8 January
22	711	George Holt, Freemasons' Arms Hotel, Market Place, Heywood.	4	121	14 January
23	881	Victoria Entwistle, Coach and Horses Inn, Bolton Road, Pendlebury.	4	171	10 January
24	884	Levi Rushton, Albert Inn, Bolton Road, Pendlebury	3	142	10 January
25	152	Edmund Goddard, Daisy Field Inn, Keb Lane, Bardsley, Ashton-under-Lyne.	—	176	11 March

Appendix No. 11.

TABLE III.

ADMINISTRATIVE COUNTY OF LANCASTER

under Section 6 of the Food and Drugs Act, 1875.

Result of Analysis.	Date and Place of hearing.	Result of Prosecution.	Remarks.
	1901 :		
Sample contains arsenic (1/4th grain per gallon).	18 January - Strangeways. Decision, 29 January.	Dismissed by Mr. Yates (Stipendiary) on the grounds that summons should have been under Section 3 and not Section 6.	Bostock's glucose used.
Sample contains arsenic (1/4th grain per gallon).	21 January - Bolton.	Withdrawn after conviction on sample No. 872.	Bostock's glucose used.
Contains much arsenic (1/2th grain per gallon).	21 January - Bolton.	Fined 5*l.* and costs. (Case stated on insufficiency of certificate, but appeal abandoned.)	Bostock's glucose used.
Contains much arsenic (1/2th grain per gallon).	21 January - Bolton.	Fined 5*l.* and costs. (Case stated on insufficiency of certificate, but appeal abandoned.)	Certificate of purity on barrel. Brewers have used Bostock's glucose, but *not* in this brew.
Contains serious quantity of arsenic (1/3rd grain per gallon).	6 February - Kirkham.	Fined 5*l.* and costs. (Case stated on insufficiency of certificate.)	Bostock's glucose used.
Sample contains arsenic (1/4th grain per gallon).	7 February - Middleton.	Adjourned, pending decision of higher Court.	Glucose from Brooks, Shudehill, Manchester.
Sample contains arsenic (1/4th grain per gallon).	16 February Nelson.	Fined 3*l.* and costs - - -	Bostock's glucose previously used, but returned stock on 30th November. Had certificate of freedom from arsenic.
Approximately 1/2 grain arsenic per gallon	16 February Nelson.	Fined 3*l.* and costs - - -	Bostock's glucose previously used, but returned stock on 30th November. Had certificate of freedom from arsenic.
Sample contains arsenic (1/4th grain per gallon).	28 January - Eccles.	Fined 5*l.* and costs. (Case stated on insufficiency of certificate. Appeal proceeding.)	Bostock's glucose used.
Contains small quantity of arsenic (1/4th grain per gallon).	31 January - Bury.	Dismissed on the ground that certificate of analyst was insufficient. Case granted. Appeal proceeding.	Brewed from malt and hops only.
Contains small quantity of arsenic (1/4th grain per gallon).	1 February - Ormskirk.	Fined 5*l.* and costs. (Case stated on the grounds that summons should have been issued under Section 3. Appeal abandoned.)	Brewers have used Bostock's glucose, but *not* in this brew.
Contains small quantity of arsenic (1/4th grain per gallon).	1 February - Ormskirk.	Adjourned pending decision of higher Court. (If against, defendant will plead guilty.)	Brewers have used Bostock's glucose, but *not* in this brew.
Contains serious quantity of arsenic (1/4th grain per gallon).	18 February Radcliffe.	Fined 20*s.* and costs. (Case stated on insufficiency of certificate. Appeal proceeding.)	Bostock's glucose used.
Contains serious quantity of arsenic (1/3rd grain per gallon).	14 March - Garstang.	Fined 20*s.* and costs - - -	Bostock's glucose used.
Contains serious quantity of arsenic (1/2 grain per gallon).	14 March - Garstang.	Fined 20*s.* and costs - - -	Bostock's glucose used.
Contains serious proportion of arsenic (1/2th grain per gallon).	25 February Colne.	Fined 20*s.* and costs - - -	Bostock's glucose used.
Contains 1/4th grain arsenic per gallon -	13 March - Rochdale.	Court sent sample to Somerset House. At re-hearing case dismissed on the ground of improper division of the sample.	Brewed from malt and hops. Somerset House find 1/5th grain.
Approximately 1/5th grain arsenic per gallon.	16 March - Preston.	Court sent sample to Somerset House. Subsequently case withdrawn, defendant to pay costs.	Brewed from malt and hops. Somerset House find 1/10th grain.
Approximately 1/4th grain arsenic per gallon.	9 February - Preston.	Fined 40*s.* and costs - - -	Brewers have used glucose (Bostock's), but *not* in this brew.
Approximately 1/5th grain arsenic per gallon.	14 March - Garstang.	Fined 20*s.* and costs - - -	Brewers have used glucose (Bostock's), but *not* in this brew.
Approximately 1/5th grain arsenic per gallon.	9 February Preston.	Fined 40*s.* and costs - - -	Brewed from malt and hops only.
1/4th grain arsenic per gallon - - -	20 February Heywood Borough.	Fined 40*s.* and costs - - -	Bostock's glucose used
1/4th grain arsenic per gallon - - -	26 February Strangeways.	Adjourned pending decision of higher Court.	Brewed from malt and hops only.
1/4th grain arsenic per gallon - - -	26 February Strangeways.	Adjourned pending decision of higher Court.	Brewed from malt and hops only
1/2 grain arsenic, calculated as arsenious oxide, per gallon.	—	Prosecution pending	—

Appendix No. 12.

APPENDIX No. 12.

TABLES HANDED IN BY PROFESSOR DELÉPINE.

TABLE I.—BEER.

No. of Sample.	Date.	Origin.	Character and Remarks.	Arsenic estimated as Arsenious Acid.			Quantity of material used for Analysis.		Remarks.
				Parts per 10,000,000 Weight.	Grains per Gallon Approximately.		Minimum CC's.	Maximum CC.'s.	
	1900.								
A	Nov. 16	Brewery A*	Brown	20 to 30	0·17	$\frac{1}{6}$	50	200	
B	„ 19	„ A*	Brown	30 to 40	0·24	$\frac{1}{4}$	25	500	Crystals visible to the naked eye, extracted from 500 cc.'s.
C	„ 19	„ A*	——	About 40	0·28	Over $\frac{1}{4}$	25	200	150 cc.'s + HNO_3 evaporated, heated after addition of H_2SO_4, tested by Marsh, give arsenic mirror.
63	„ 29	„ H*	Pale brown, clear (4d.)	4 to 5	0·033	$\frac{1}{30}$	—	200	
64	„ 29	„ H*	Pale brown, clear (6d.)	7	0·049	$\frac{1}{20}$	—	200	
65	„ 29	„ H*	Pale brown, clear (Bitter.)	10	0·070	$\frac{1}{14}$	—	200	
66	„ 30	„ C*	Slightly turbid and sour.	5 to 7	0·042	$\frac{1}{24}$	—	150	
67	„ 30	„ F*	Pale brown, turbid	5	0·035	$\frac{1}{28}$	—	150	
68	„ 30	„ J	„ „ „	3 to 5	0·028	$\frac{1}{35}$	—	150	
69	„ 30	„ H*	Somewhat turbid	5 to 10	0·049	$\frac{1}{20}$	—	150	
70	„ 30	„ K	„ „	Trace	—	—	—	150	
71	„ 30	„ A*	——	20	0·14	$\frac{1}{7}$	—	150	
72	„ 30	„ E*	——	120	0·84	$\frac{5}{6}$	—	150	
73	„ 30	„ L*	——	10	0·070	$\frac{1}{14}$	—	150	
74	„ 30	„ M*	——	5	0·035	$\frac{1}{28}$	—	150	
75	„ 30	„ N	——	0?	—	—	—	150	
76	Dec. 8	„ A	From malt and hops	1 to 5	0·021	$\frac{1}{47}$	—	200	
77	„ 8	„ A	Malt and hops	2	0·014	$\frac{1}{70}$	—	200	
78	„ 8	„ A	Stout	1 to 5	0·021	$\frac{1}{47}$	—	200	
95	„ 26	„ F	Made with malts 93, 94, 97, 98 (Table II.) blended.	2	0·014	$\frac{1}{70}$	—	100	
96	„ 26	„ F	*Id.*	5	0·035	$\frac{1}{28}$	—	100	
IX.	„ 1	Private *	——	220	1·54	$1\frac{1}{2}$	—	18	This is the worst sample examined in the laboratory, it was received at the beginning of the scare.
H.	Nov. 23	Munich	Dark lager	0	—	0	100	1,000	This beer was taken at the beginning of the inquiry to serve as a standard of comparison.
I.	„ 23	Vienna	Light lager	0	—	0	—	100	Ditto.

* Breweries used Bostock Sugars.

N.B.—In the column headed parts per 10,000,000, the actual results of analyses are given; when only one figure is given the quantity recorded may be considered as correct within less than $\frac{1}{10}$ grain, when two figures are given the estimation is somewhat less accurate. The quantities in grains per gallon and per pound have been calculated from the amount estimated in parts per 10,000,000, only the mean being given when two extremes are given in the first column. The estimates in vulgar fractions are the least accurate, owing to the necessity of simplifying some unwieldy fractions.

Appendix No. 12.

TABLE II.—MALT.

No. of Sample.	Date.	Origin.	Special Marks.	Character and Remarks.	Arsenic estimated as Arsenious Acid.			Quantities of Material used for Analysis.		Maximum possible amount introduced in Beer brewed entirely from Malt (supposing 1 part of Malt to 4 parts of Beer).	Remarks.
					Parts per 10,000,000 weight.	Grains per pound approximately		Minimum Grammes.	Maximum Grammes.		
	1900.									Grains per Gallon.	
28	Nov. 23	Brewery A	26	——	0	—	—	—	15	—	
29	,, 23	,, A	27	——	3	0·0021	$\frac{1}{48}$	15	30	$\frac{1}{12}$	
30	,, 23	A	28	——	0	—	—	—	15	—	
31	,, 23	A	29	——	3·3	0·0023	$\frac{1}{43}$	15	30	$\frac{1}{12}$	
32	,, 23	,, A	30	——	0	—	—	—	15	—	
33	,, 23	,, A	31	——	Over 3	0·0025	$\frac{1}{40}$	—	15	$\frac{1}{12}$	
34	,, 23	,, A	32	——	0	—	—	—	15	—	
79	Dec. 21	,, O	5	Collected on 21st November.	10 to 12·5	0·0077	$\frac{1}{13}$	—	40	$\frac{1}{5}$	
80	,, 21	,, O	6	,, ,,	2	0·0014	$\frac{1}{70}$	—	40	$\frac{1}{18}$	
81	,, 21	,, O	7	,, ,,	2	0·0014	$\frac{1}{70}$	—	40	$\frac{1}{18}$	
82	,, 21	,, O	8	,, ,,	3·5	0·0025	$\frac{1}{40}$	—	30	$\frac{1}{12}$	
83	,, 21	,, P	2	——	16·5 to 33	0·0175	$\frac{1}{17}$	—	30	$\frac{1}{8}$	
84	,, 21	,, F	13	——	16	0·0112	$\frac{1}{26}$	—	30	$\frac{1}{8}$	
85	,, 21	,, F	14	——	5	0·0035	$\frac{1}{28}$	—	30	$\frac{1}{11}$	
86	,, 21	,, F	15	——	3·3	0·0023	$\frac{1}{43}$	—	30	$\frac{1}{18}$	
87	,, 21	,, F	16	——	3·3 to 16·5	0·007	$\frac{1}{14}$	—	30	$\frac{1}{6}$	
88	,, 21	,, F	17	——	About 3·3	0·0023	$\frac{1}{43}$	—	30	$\frac{1}{12}$	
89	,, 21	,, N	44	——	4 to 20	0·0084	$\frac{1}{12}$	—	25	$\frac{1}{4}$	
90	,, 21	,, N	45	——	About 8	0·0056	$\frac{1}{17}$	—	10	$\frac{1}{6}$	
91	,, 21	,, N	46	——	,, 10	0·007	$\frac{1}{14}$	—	25	$\frac{1}{6}$	
92	,, 21	,, N	47	——	,, 20	0·014	$\frac{1}{70}$	—	30	$\frac{1}{8}$	
93	,, 26	,, F	—	Horncastle New Black. (See Beers 95 and 96).	,, 5	0·0035	$\frac{1}{28}$	—	30	$\frac{1}{11}$	
94	,, 26	,, F	—	Soames Californian. (See Beers 95 and 96.)	,, 2	0·0014	$\frac{1}{70}$	—	30	$\frac{1}{18}$	
97	,, 26	,, F	—	Old Black. (See Beers 95 and 96).	,, 16	0·0112	$\frac{1}{26}$	—	30	$\frac{1}{8}$	
98	,, 26	,, F	—	Old Plain Strong Worksop. (See Beers 95 and 96.)	16 to 23	0·013	$\frac{1}{22}$	—	30	$\frac{1}{7}$	
	1901.										
99	Jan. 8	,, F	0	Dried with new fuel.	3·3	0·0023	$\frac{1}{43}$	—	30	$\frac{1}{14}$	
115	,, 23	Maltsters Z	—	Modern Kiln.	Trace?	—	—	30	100		
116	,, 23	,, Z	—	,,	Trace?	—	—	30	100	—	

Appendix No. 12.

TABLE III.—HOPS.

No. of Sample.	Date.	Origin.	Character and Remarks.	Arsenic estimated as Arsenious Acid.			Quantity of material used for analysis. Grammes.	Maximum possible amount introduced into a Gallon of Beer on the supposition that 1 % Hops is used.	Remarks.
				Parts per 10,000,000 weight.	Grains per pound approximately.				
	1900.							Grains per Gallon.	
1	Nov. 21	Brewery P	Pale yellow, good aroma	0?	–	–	5	0	
2	„	„ O	Pale green, aroma slight	0?	–	–	5	0	
3	„	„ O	Yellow, aroma strong	5 to 10	0·005	$\frac{1}{280}$	10	$\frac{1}{2800}$	
4	„	„ F	Aroma strong	5 „ 10	0·005	$\frac{1}{280}$	10	$\frac{1}{2800}$	
5	„	„ F	Yellow green, sour	5 „ 10	0·005	$\frac{1}{280}$	10	$\frac{1}{2800}$	
6	„	„ F	Aroma slight	5 „ 10	0·005	$\frac{1}{280}$	10	$\frac{1}{2800}$	
7	„	„ F	Greenish, aroma strong	Trace	–	–	5	–	
8	„	„ A	Yellow and greenish, aroma slight.	„	–	–	5	–	
9	„	„ A	Greenish yellow, aroma faint.	5 to 10	0·005	$\frac{1}{280}$	5	$\frac{1}{2800}$	
10	„	„ A	Brownish yellow, aroma slight.	10 „ 20	0·010	$\frac{1}{140}$	5	$\frac{1}{1400}$	
11	„	„ A	Yellow, aroma slight	0	–	–	5	–	
12	„	„ A	Pale yellow, aroma moderate.	0	–	–	5	–	
13	„	„ N	Greenish yellow, aroma moderate.	About 10	0·007	$\frac{1}{200}$	10	$\frac{1}{2800}$	
14	„	„ N	Brownish yellow, aroma slight.	0	–	–	10	–	
16	„	„ N	Brownish yellow, aroma slight.	About 10	0·007	$\frac{1}{200}$	10	$\frac{1}{2800}$	
16	„	„ N	Greenish yellow, aroma moderate.	0	–	–	10	–	
17	„	„ N	Brownish yellow, aroma slight.	0?	–	–	10	–	
18	„	„ N	Greenish yellow, aroma slight.	5 to 10	0·005	$\frac{1}{280}$	10	$\frac{1}{2800}$	
19	„	„ N	Yellowish, aroma slight	0	–	–	5	–	
20	„	„ N	Brownish yellow, aroma very slight.	About 10	0·007	$\frac{1}{200}$	10	$\frac{1}{2800}$	

Appendix No. 12.

TABLE IV.—BREWING SUGARS.—GLUCOSE.

No. of Sample.	Date.	Origin.	Character and Remarks.	Arsenic estimated as Arsenious Acid.			Quantities of Material used for Analysis.		Maximum possible amount introduced into a gallon of Beer, on the supposition that only 5 per cent. sugar is used.		Remarks.
				Parts per 10,000,000 weight.	Grains per pound approximately.		Minimum Grammes.	Maximum Grammes.	Grains per gallon.		
	1900.										
21	Nov. 22	Brewery A	Yellowish	0	—	—	—	10	—	—	
22	„ 22	„ A	Deep Brown	0	—	—	—	10	—	—	
23	„ 22	„ A*	Yellow	6,000	4·2	4⅓	—	10	2·1	2 1/10	Tested by Marsh gives a good arsenical mirror.
24	„ 23	„ O	Pale Yellow	10	0·007	1/140	—	15	0·0035	1/280	
37	„ 23	„ P	Pale Yellowish Brown.	7	0·005	1/200	—	15	0·0025	1/400	
38	„ 23	„ N	Pale Yellowish Brown.	0?	—	—	—	15	—	—	
39	„ 23	„ N	Pale Yellowish Brown.	0?	—	—	—	15	—	—	
44	„ 23	Bostock*	Dark Brown (compact).	9,500	6·65	6⅔	0·010	15	3·3	3⅓	
45	„ 23	„ *	Yellowish White.	Ab. 1,500	1·05	1 1/20	0·20	15	0·5	½	
46	„ 23	„ *	White	Ab. 1,500	1·05	1 1/20	0·20	15	0·5	½	
47	„ 23	„ *	Pale Yellow	Ab. 5,000	3·5	3½	0·02	15	1·7	1 7/10	
48	„ 23	„ *	Brownish Yellow.	6,000	4·2	4⅓	0·016	15	2·1	2 1/10	
49	„ 23	„ *	Dark Brownish Yellow.	4,000	2·8	2⅔	0·025	15	1·4	1⅓	
62	„ 29	Confectioner	Glucose solution containing also S O²	0	—	—	10	15	—	—	

INVERT SUGAR.

									Supposing 5 per cent. used as substitute.		Supposing 0·15 per cent. used for priming.	Total.
25	Nov. 23	Brewery O	Honey-like solution.	0?	—	—	—	20	—	—	—	—
26	„ 23	„ A*	Syrupy solution containing 36 per cent. solid. Arsenic estimated in the solid invert.	800	0·56	½	0·125	40	0·28	¼	0·008	0·288
40	„ 23	„ F*	Crystallised honey-like, solid not estimated.	2,000	1·4	1⅓	0·125	15	0·70	7/10	0·021	0·72
41	„ 23	„ F	Honey-like pale yellow, solid not estimated.	7	0·005	1/200	—	15	0·0025	1/400	0·000075	0·0025
50	„ 23	Bostock	Semi-fluid, honey-like pale yellow, solid not estimated.	1,430	1	1	0·07	15	0·5	⅓	0·015	0·515
51	„ 23	„	Greyish yellow, slightly more solid than 50.	2,000	1·4	1⅓	0·05	15	0·7	7/10	0·021	0·721

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TABLE V.—YEAST.

No. of Sample.	Date.	Origin.	Character and Remarks.	Arsenic estimated as Arsenious Acid.			Quantities of Material used for Analysis.		Remarks.
				Parts per 10,000,000 weight.	Grains per pound approximately.		Minimum Grammes.	Maximum Grammes.	
	1901.								
106	Jan. 14	Brewery F	Yeast in use on 14 Jan. 1900.	6·6	0·0046	$\frac{1}{220}$	—	30	
107	„ 14	„ A	Yeast in use on 14 Jan. 1900.	20	0·014	$\frac{1}{70}$	—	30	
XIV.	Feb. 8	„ B	Yeast in use on 31 Dec. 1900.	82	0·0574	$\frac{1}{17}$	—	30	
XIII.	„ 8	„ B	Yeast in use on 15 Jan. 1901.	100	0·07	$\frac{1}{14}$	—	30	

TABLE VI.—MATERIAL OTHER THAN MALT, HOPS, YEAST, AND SUGAR USED IN BREWING.

No. of Sample.	Date.	Origin.	Character and Remarks.	Arsenic estimated as Arsenious Acid.			Quantity of Material used for Analysis.	
				Parts per 10,000,000 weight.	Grains per lb. approximately.		Minimum Grammes.	Maximum Grammes.
	1900.							
27	Nov. 23	Brewery A	Water	0	—	—	—	200
35	„ 23	„ A	Gypsum (white powder)	0	—	—	—	15
57	„ 29	„ F	„ „	7	0·005	$\frac{1}{14}$	—	15
36	Nov. 23	Brewery A	Preservative (Sulph. of potash).	0	—	—	—	10
58	„ 29	„ F	Clear fluid, smell of SO_2 (Sulph. or bisulph. of potash.)	45	0·0315	$\frac{1}{32}$	25	40
59	Nov. 29	Brewery F	Isinglass, turbid fluid	0	—	—	—	40

TABLE VII.—PREPARATION OF MALT.

No. of Sample.	Origin.	Special Marks.	Character and Remarks.	Arsenic estimated as Arsenious Acid.			Quantity of material used for Analysis.		Maximum amount introduced into a Gallon of Beer (See Malt grains).	Remarks.
				Parts per 10,000,000 weight.	Grains per pound approximately.		Minimum Grammes.	Maximum Grammes.		
117	Maltster X	1	Clean, pale, full-grown barley.	0?	—	—	—	100	0	
118	„	2	—	0	—	—	—	100	0	
119	„	3	Dark and poor in appearance - -	Trace?	—	—	—	100	0	
120	„	4	Dark and poor -	0?	—	—	—	100	0	
121	„	5	Clean, pale, full-grown.	Trace?	—	—	—	100	0	Kiln dried.
122	„	6	Intermediate appearance.	Trace?	—	—	—	100	0	Kiln dried.
100	Maltster Y		Malt ready for kiln drying.	0?	—	—	—	30	0	
101	„	—	Culms from old fuel	132	0·0924	$\frac{1}{11}$	—	30	—	
102	„	—	Dust from underneath drying kiln	264	0·1848	$\frac{1}{5\frac{1}{2}}$	—	30	—	
111	Maltster X	—	Malt not screened or polished.	11	0·0077	$\frac{1}{11\frac{1}{2}}$	—	30	$\frac{1}{2\frac{1}{2}}$	
112	„	—	Screened and polished Malt, same as 111.	3·3	0·0022	$\frac{1}{34\frac{1}{2}}$	—	30	$\frac{1}{11\frac{1}{2}}$	
113	„	—	Culms from 111 -	1,500	1·05	$1\frac{1}{25}$	—	10	—	
114	„	—	Malt dust from 111	4,000	2·8	$1\frac{1}{3}$	—	10	—	
115	Maltster Z	—	Malt from modern kiln.	0?	—	—	—	100	—	Repeated from Malt tables for comparison.
116	—	—	Malt from modern kiln.	0?	—	—	—	100	—	Ditto.

FUEL.

103	Maltster Y	—	Anthracite Coal -	5?	0·0035?	$\frac{1}{285}$	—	10	—	
104	„	—	Coke (Gas) - -	100	0·07	$\frac{1}{14}$	2·5	10	—	
105	„	—	Coke purified -	80	0·056	$\frac{1}{17}$	2·5	10	—	
108	Maltster X	—	Anthracite Coal -	Small amount.	—	—	—	10	—	Detected by Marsh's test.
109	„	—	Coke (Retort) -	2,000	1·4	$1\frac{1}{2}$	0·5	10	—	
110	„	—	Coke - - -	325	0·2275	$\frac{1}{4\frac{1}{2}}$	0·5	10	—	

Appendix No. 12.

TABLE VIII.—MATERIAL USED IN THE PREPARATION OF BREWING SUGARS.

No. of Sample.	Date.	Origin.	Character and Remarks.	Arsenic estimated as Arsenious Acid.			Quantity of Material used for Analysis.		Remarks.
				Parts per 10,000,000 weight.	Grains per lb. approximately.		Minimum Grammes.	Maximum Grammes.	
			RAW MATERIAL:						
52	1900. Nov. 23	Bostock	Maize Meal	0	—	—	—	15	
53	„	„	Sago Flour, brown mixed with woody fibre	0	—	—	—	15	
54	„	„	Tapioca Flour, greyish white, lumpy.	0	—	—	—	15	
55	„	„	Cane sugar, brown soft.	0	—	—	—	15	
			ACID FOR CONVERTING:						
42	Nov. 23	Bostock	Sulphuric Acid, B.O.V., very dark, cloudy, white deposit, Sp. gr., 1·73.	145000	101·5	—	0·00066	2	Two drops tested by Marsh's method gave a good arsenical mirror. White precipitate contains a very large amount of arsenic estimated by ordinary gravimetric method—more than 3·10 per cent. QUALITATIVE TESTS: =Traces of lead. „ „ calcium. An appreciable amount of iron. No selenium.
			ACID USED FOR BLEACHING:						
43	Nov. 23	Bostock	Sulphurous Acid	10 (in vol.)	0·007	$\frac{1}{143}$	40	45	
			CARBONATE OF CALCIUM USED FOR NEUTRALISING:						
56	Nov. 23	Bostock	Whiting	0	—	—	—	10	
			CHARCOAL USED FOR DECOLOURISING AND PURIFYING:						
60	Nov. 23	Bostock	Charcoal before Reburning.	9000 (About)	6·3	$6\frac{1}{3}$	—	15	
61	„	„	Charcoal after Reburning.	8000	5·6	$5\frac{1}{2}$	—	15	

TABLE IX.—ARSENIC IN THE BODY OF A BEER DRINKER.

Date.	——	Arsenic estimated as Arsenious Acid.			Quantity of Material used for Analysis.		Remarks.
		Parts per 10,000,000 weight.	Quantity of Arsenic contained in 3 lbs. of urine, *i.e.*, per diem in grains.		Minimum Grammes.	Maximum Grammes.	
1900. Dec. 24	Urine from patient suffering from arsenical poisoning due to drinking Salford beer.	1·2	0·00252	$\frac{1}{278}$	—	150	

TABLE IX.A.

FUEL.

—	Material.	Parts per 10,000,000, about.	Grains per pound.	Quantity of Material used.
				Grammes.
M 32	Soot deposited in flue of a chimney after burning good house coal (South Yorkshire Colliery) for one week	8,000	5·6	0·5
	Flue cleaned once a week.			
M 33	Soot deposited in flue of a closed stove, after burning Corporation Gas Works Coke for 15 days	40,000	28	0·025
	Flue cleared once in a fortnight, the amount of soot obtained weighing about 113 grammes. This amount contains about half a gramme of arsenious acid.			
M 34	Soot produced by a single gas jet (Manchester gas) burning for 3 hours and a half (combustion in confined space). Water produced during combustion added to the soot	0 (?)	—	0·41
	No appreciable amount of gaseous compound of arsenic appears to be present in gas manufactured from coals from which the above coke was obtained (M 33), *i.e.*, in purified gas as supplied to the consumer.			

DISSEMINATION OF ARSENICAL SOOT THROUGH THE AIR.

M 40	A. Leaves of evergreen shrubs (laurels, rhododendrons, ivy, holly), collected in a garden in Victoria Park (Manchester), leaves blackened by soot selected. There had been much rain for several days previous to the collection of the leaves	4	—	Grammes. 30
	Thirty grammes of leaves represent an area of about 1,044 sq. c.m.			
	B. Soot washed from the surface of 50 grammes of leaves (it was impossible to remove all the soot)	2	—	50
	It was not possible to clean the leaves sufficiently completely to estimate what amount of arsenic (if any) had penetrated into the tissues of the leaves.			
	C. Leaves of evergreen shrubs (laurels, ivy), collected in Streatham, near London, in a garden surrounded by large gardens and fields. There had been rain for several days. Old leaves were selected but no special care was taken to obtain only those covered with soot	under 0·5	—	50
	D. Leaves of evergreen shrubs (laurels, ivy), collected in a small town garden in Montreux, Switzerland. The garden was surrounded by houses. There had been rain for several days. The oldest and most dusty leaves were selected, but none showed any evidence of the presence of soot. The town is very small. Of late coal fires have been used, but wood is still the chief combustible	0 (?)	—	50

COMBUSTION OF TOBACCO.

M 39	Products of combustion of half ounce of tobacco, obtained by bubbling slowly the smoke through water. No appreciable trace of arsenic was found	0	—	Grammes. —
	This experiment and the one on gas soot may be looked upon as control experiments for comparison with the others.			

Appendix No. 12.

TABLE X.—GENERAL RESULTS OF AUTOPSIES OF FATAL CASES OF ARSENICAL POISONING.

To Professor Sheridan Delépine—In accordance with your request, I beg to submit the following information on the points specified by you as determined by autopsies on cases of "Arsenical Beer Poisoning."

No.	Sex.	Age.	Nutrition.	Associated Diseases.	
1	M.	53	Fair. No marked wasting of muscles.	Pulmonary tuberculosis	Tuberculosis of pleuræ and peritoneum.
2	F.	46	Emaciated. Marked wasting of muscles.	Pulmonary tuberculosis with cavitation.	Tuberculosis of pleuræ and peritoneum.
3	M.	31	Well nourished. No muscular wasting.	Pulmonary tuberculosis "consolidation."	General miliary tuberculosis.
4	F.	53	Fair. Muscles of extremities wasted.	Old tuberculosis at apices, recent pneumonia.	Tuberculosis of pleuræ, peritoneum, liver and kidneys.
5	F.	30	Fair. Muscles of extremities wasted.	Pulmonary tuberculosis with cavitation.	Tuberculosis of pleuræ and peritoneum.
6	M.	50	Fair. Muscles of legs wasted	Extensive tuberculous broncho-pneumonia.	Tuberculosis of pericardium, pleuræ, peritoneum, liver, spleen and kidneys.
7	M.	44	Emaciated. Muscles of limbs much wasted.	Pulmonary tuberculosis not advanced nor extensive.	Tuberculosis of pleuræ and peritoneum.
8	M.	40	Well nourished. No muscular wasting.	Pneumonia (?) tuberculous	Tuberculosis of pleuræ and peritoneum.
9	F.	(?)	Emaciated. Muscles of extremities much wasted.	Hypostatic pneumonia	——
10	F.	42	Emaciated. Muscles of extremities wasted.	Pulmonary tuberculosis with cavitation.	Tuberculosis of pleuræ and peritoneum.
11	F.	34	Fair. Muscles of legs wasted	Hypostatic pneumonia.	——
12	F.	(?)	Emaciated. Muscles of limbs wasted.	Pulmonary tuberculosis, not advanced.	——
13	F.	54	Fat. Muscles of extremities little wasted.	Broncho-pneumonia, old foci of tuberculosis in lungs.	——

In addition, it may be stated that typical periaxial degeneration of the peripheral nerves, varying in degree, has been found in such of the above cases as have been examined, viz., cases 1 to 12 inclusive. The livers in many of the cases presented irregularly-distributed congestion, degeneration, and varying degrees of cirrhosis. Further the skin in many of the cases was pigmented in varying degrees.

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Assistant Lecturer in Pathology and Morbid Anatomy,
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TABLE XI.

INTERIM REPORT of Dr. FRANCIS J. H. COUTTS on the PRESENCE OF ARSENIC IN FOOD PRESERVATIVES, &c.

Reference Number.	Material.	Arsenic as As_2O_3 in parts per 10,000,000.	Arsenic in grains per pound, approximately.	Weight used.
				Grammes.
M 129	English shrimps, in paper package	2	1-700th.	100
M 128	"German" shrimps, in paper package, in cardboard box along with M 129. Said to be German, imported to be sold as English	About 13	1-100th.	100
M 127	"Pure English" shrimps, said not preserved (a specimen received later than M 129)	2	1-700th.	100

Materials possibly used in Preservation of Food Stuffs.

M 121	Nitre (such as was formerly used for preserving pathological specimens)	15	1-90th.	Grammes. 15
M 114	Potassium nitrate (bought from drysalter)	Trace	——	15
M 120	Borax (bought from grocer)	50 to 60	1-28th to 1-23rd.	15
M 112	"Refined borax" (drysalter)	7	1-180th.	15
M 119	Boracic acid (from druggist)	—	——	15
M 113	Boracic acid (drysalter)	Trace	——	15
M 118	Common salt (household)	—	——	15
M 117	Freezing salt	Trace	——	15
M 111	"Bay" salt (drysalter)	Trace	——	15

Other Chemicals.

M 116	Sodium sulphate	2 to 3	1-700th to 1-500th.	Grammes. 15
M 115	Sodium carbonate (crystals)	6	1-240th.	15
——	"Pure" hydrochloric acid ("redistilled")	Trace	——	100cc.

By FRANCIS J. H. COUTTS, M.D., D.P.H., F.C.S.,
Assistant in the Bacteriological Laboratory,
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Appendix No. 12.

J. Clouet (Annales d' Hygiene Publique 1878, p. 145), in searching for the source of the arsenic sometimes present in wine, found that fuchsin is often incriminated wrongly, but that the caramel which is frequently used in conjunction with fuchsin often contains a large amount of the poison. Ritter had previously shown this to be the case. These two observers found that the arsenic is derived from impure sulphuric acid which is not infrequently used in the preparation of glucose from which caramel is made. Arsenic is always more or less abundant in sulphuric acid prepared from arsenical pyrites. In addition to arsenic, glucose frequently contains a large proportion of free sulphuric acid, this being the effect of imperfect neutralisation of the acid after conversion of starchy matters. The results of Clouet's and of Ritter's analyses may be tabulated as follows:—

TABLE XII.

Analyses of Arsenical Pyrites, Sulphuric Acid, and Glucose, by Professor Clouet and Professor Ritter.

Substance.	Source.	Observer.	Arsenious Acid, in grammes per kilogram.	Arsenious Acid. Parts in 10,000,000.	Arsenious Acid. Grains per lb.
Pyrites	Siegen (Westphalia)	Clouet	0·026	260	0·182
	Chessy, near Lyons (France)	„	0·00022	2·2	0·00154
Sulphuric Acid	Fabrique des Vosges	Clouet	Max. 1·80	18,000	12·6
		Ritter	Min. 0·59	5,900	4·13
Glucose	†Luneville (Vosges)	Clouet	Max. 0·009	90	0·063
			‡Mean 0·0066	66	0·0462
			Min. 0·0033	33	0·0231
	La Briche (near Paris)	„	Slight trace.	—	—
	†Aubervilliers	„	Traces unweighable.	—	—
	†Bourget	„	0	—	—
	†Rueil	„	0	—	—
	German Glucose, white	Ritter	0·013	130	0·09
	„ „ yellow	„	0·022*	220	0·154
	„ „ dark	„	0·1438	1,438	1·006

Free Sulphuric Acid in Glucose.

Glucose	Luneville (Vosges)	Clouet	Max. 4·980	—	34·860
			‡Mean 2·716	—	19·012
			Min. 1·327	—	9·273

Calculated Amount of Arsenic that might be introduced in Beer Brewed from Arsenical Glucose.

					Grs. per gal.	
Beer	From White Glucose	Ritter	0·00050	5	0·035	$\frac{1}{28}$
	„ Black	„	0·00547	54·7	0·38	$\frac{1}{3}$

* In this table the arsenic has been given as arsenious acid, and the quantities found in 10,000,000 and per lb. have been calculated from the figures given in the original paper, in which the poison is estimated as *arsenicum*.

† Process of manufacture the same, but sulphuric acid used different.

‡ Mean of all the analyses made by the observer, including maxima and minima.

TABLE XIII.

QUANTITY of ARSENIC found in various MINERAL WATERS. (Q. 5309.)

Name of Spa.	Country.	Arsenical Compound.	Authority.	Quantity in parts.	
				Per 1,000.	Per 7,680.
Baden-Baden	Germany.				
Murquelle	—	Arseniate of Iron	Bunsen	Trace.	—
Fettquelle	—	"	"	—	0·0068
Bourboule	France.				
Choussy	—	Arsenious Acid	—	0·0115	—
Perrière	—	"	—	0·0108	—
Contrexéville—Pavilion Spa	France	Arsenic	Debray	Trace.	—
Mondorf	Luxemberg	Arsenic Acid	Kircholf	—	0·001
Rippoldsau	Germany.				
Josephquelle	—	Arsenic	Bunsen	—	Traces.
Leopoldsquelle	—	"	"	—	"
Vals	France.				
Saint Jean	—	Arseniate of Soda	M. Henri	Traces.	—
Précieuse	—	"	"	"	—
Désirée	—	"	"	"	—
Rigolette	—	"	"	"	—
Magdeleine	—	"	"		—
Vichy	France.				
Grande Grille	—	Arseniate of Soda	Bouquet	0·002	—
Hôpital	—	"	"	0·002	—
Célestins	—	"	"	0·003	—
Hauteride	—	"	"	0·002	—
Wiesbaden	Germany	Arseniate of Lime	Fresenius	—	0·001

Appendix No. 13.

APPENDIX No. 13.

Papers handed in by Mr. H. Weld Blundell.

With reference to the proportion of Invert Sugar in use at the Cornbrook Brewery, Mr. Blundell has supplemented his evidence by instances of particular brews at various dates in August and September, 1900, in which the proportions were as follows:—

Date of Brew and Quality of Beer.	Percentage of Invert Sugar to total Materials used.	Pounds weight of Invert Sugar used per Gallon of Beer produced.
3rd August, 1900, Bitter Beer, No. 492 - -	12·06	·14
9th „ „ Quality C, No. 501 - -	11·94	·14
22nd „ „	11·11	·12
5th September, 1900, Quality C.B.B. (Bitter Beer), No. 538 - - - -	10·41	·12
20th September, 1900, Stout, No. 560 - -	11·11	·18
28th „ „ Quality X, No. 569 -	11·11	·12
10th October, 1900, Quality X, No. 113 - -	11·11	·12
2nd November, 1900, Stout, No. 142 - -	11·11	·15
7th „ „ Bitter Beer, No. 146 -	11·56	·13
15th „ „ Stout, No. 156 - -	11·11	·15

APPENDIX No. 14.

HANDED IN BY SIR LAUDER BRUNTON.

Extrait du Bulletin de l'Académie de Médecine, 1888. No. 27. 3e Série, Tome XX., p. 617.

Sur les communications de MM. VIDAL, MARQUEZ *et* DUBRANDY, *relatives à l'affaire des vins empoisonnés d'Hyères au nom d'une Commission composée de* MM. E. VIDAL *et*

A. OLIVIER, *rapporteur.*

Vers la fin d'hiver dernier, une maladie bizarre, avec des troubles digestifs, des exanthèmes sans forme déterminée, des accidents nerveux capables de faire songer à une affection de la moelle épinière, se développait dans une partie de la population d'Hyères ; elle frappait de préférence des ouvriers et des petits employés, semblant épargner les femmes, les enfants et les classes aisées. Comme les premiers cas étaient peu graves, on n'y prêta guère attention ; à mesure qu'ils devenrent plus nombreux, la population s'émut, les médecins échangèrent différentes observations au sujet des malades qu'ils venaient de traiter, et, en finde compte, en reconnut de tous les cas de la prétendue maladie, épidémique d'Hyères étaient des cas d'intoxication par l'arsenic.

Toute cette affaire a été l'objet d' une enquête juridique et de débats sur lesquels nous n'avons pas l'intention de revenir. En revanche, l'Académie a reçu des documents intéressants au point de vue de l'étude clinique de l'empoisonnement par l'acide arsénieux administré à doses faibles, repétées, dans un produit alimentaire, le vin.

Le 19 juillet, un premier mémoire renfermant à l'observation détaillée et très précise d'un des faits en question lui était adressé par M. le Dr E. Vidal (*De la similitude des symptômes de l'acrodynie et de l'intoxication lente par l'acide arsénieux*). Ce travail contient en outre une analyse bien faite et une discussion très serrée sur la nature même de la maladie. Le 21 juillet l'Académie recevait un autre mémoire de M. le Dr Marquez (*Acrodynie et arsénicisme*) relatif aux mêmes faits ; enfin, le 14 août, une étude du Dr Dubrandy (*Contribution à l'étude de l'empoisonnement chronique par l'arsenic*), portant sur une soixantaine de faits, venait s'ajouter aux deux précédents. Tous ces documents ont été renvoyés à une Commission composée de MM. Emile Vidal et Auguste Ollivier, rapporteur. C'est au point de vue de cestravaux très détaillés, consciencieux, irréprochables au point de vue clinique, que je vais essayer d'esquisser l'histoire des faits qui se sont passés à Hyères à la fin de l'hiver 1887 et au commencement du printemps de l'anné 1888.

L'hiver en question fut froid rigoureux, accompagné de grippes, dont quelques-unes présentèrent des phénomènes gastro-intestinaux et furent suivies d'un abattement, d'un affaiblissement musculaire plus marqué et plus persistant qu'il ne l'est d'habitude à la suite de l'influenza. A cet égard, la même remarque avait été faite par tous les médecins. Lorsque, plus tard, on eut découvert le *corpus delicti*, tous furent unanimes à déclarer que l'ingestion du vin était probablement pour quelque chose dans les accidentsqu'ils avaientauparavant eu l'occasion de noter à diverses reprises. Dès le 8 février, le Dr Vidal donne ses soins à une employé du chemin de fer, présentant les symptômes ordinaires d'un embarras gastrique de moyenne intensité. Ces symptômes s'atténuent sous l'influence du traitement et font place à une diarrhée modérée, mais persistante. Le 4 mars, se montrent sur différents points du corps des taches rouges, prurigineuses, urticariformes, et dont la régression ne suit point la marche que suit d'habitude celle des plaques d'urticaire. Pendant tous le mois de mars différents phénomènes se succèdent irrégulièrement, sans qu'on puisse connaître les connexions pathogènes qu'ils présentent. Ce sont : un catarrhe des voies respiratoires avec sécrétion peu abondante, mais accompagnée de toux spasmodique et d'accès de dyspnée, une inappétence et une diarrhée persistantes ; enfin, le 31 mars, apparaissent les phénomènes paralytiques qui ont existé dans la plupart des cas observés et en ont constitué le caractère le plus frappant. Les jambes sont le siège de différents troubles sensit fs (douleurs, fourmillements, élancements) ; les mains sont prises à la tour, et, malgré cela, il y a aux membres supérieurs comme aux membres inférieurs de l'hypéresthésie cutanée, à tel point que le contact des draps ne peut être supporté et que le malade est obligé de sortir presque constamment les pieds du lit ; les mouvements sont difficiles, les jambes semblent trop lourdes pour la marche. En présence d'un pareil complexus, M. Vidal arrive à songer à une maladie épidémique, de nature mal connue, observée à plusieurs reprises, mais particulièrement vers 1830 à Paris et dans les environs, à l'acrodynie. Cette idée le conduisit naturellement à penser à l'alimentation des malades, car, malgré l'incertitude qui règne sur la nature de l'acrodynie, malgré le résultat négatif des recherches entreprises aux époques d'épidémie, l'opinion générale qui a toujours persisté relativement à sa nature, c'est que c'était une maladie d'alimentation plus ou moins comparable à l'ergotisme au lathyrisme et à la pellagre.

Des accidents analogues à ceux qu'a décrits M. Vidal étaient notés par tous les médecins d'Hyères ; ainsi, du 13 février au 3 avril, M. Dubrandy est appelé par des malades qui tous se plaignent de faiblesse musculaire, de fourmillements, d'une douleur des membres inférieurs, parfois assez vive pour les empêcher de dormir pendant la nuit. Il est probable que, dès le milieu de mars, l'opinion s'était répandue dans le corps médical et même dans la population, que la maladie régnante presentait quelque chose d'anormal, et que, selon toute probabilité, il y avait un élément nocif, inconnu, dans les substances qu'on absorbait d'habitude. L'aspect clinique rappelait si bien une maladie due aux ingesta qu'à une date non precisée, mais certainement antérieure à la découverte de la véritable cause, le Dr Decurgis, soignant plusieurs ouvriers de M. X....., le propriétaire poursuivi plus tard, leur demanda formellement s'ils étaient bien fixés sur la nature du vin qu'ils buvaient. Après leurs protestations unanimes, il abandonna ses soupçons et chercha dans un autre sens.

Ce fut le Dr Charles Roux qui découvrit le premier la véritable cause. Le 4 avril, ce médecin déclarait à la commission d'hygiène d'Hyères que les accidents rapportés soit à l'acrodynie, soit à des grippes anormales, se developpaient exclusivement chez des individus buvant un vin de provenance déterminée. Pour faire une pareille déclaration, il avait fallu que la conviction de l'auteur fût étayée sur des faits si probants, qu'à leur égard toute discussion fût superflue. Il ne s'agissait plus, en effet, d'une opinion scientifique, susceptible d'être soutenue ou combattue sans provoquer une vive émotion dans le public. L'opinion de M. Roux contenait une accusation capable de server de base à une action juridique et d'avoir des conséquences commerciales faciles à prévoir. En fait, il y avait en dans le développement antérieur de la soi-distant épidémie une série de circonstances capables de donner à réfléchir. "Jusqu'au 20 mars, dit le Dr Dubrandy, j'avais toujours supposé que les accidents pourraient bien être d'origine alcoolique et produits par l'usage d'alcools absorbés en nature ou sous forme de vins vinés pris en excès."

La commission d'hygiène se réunit de nouveau le 16 avril. M. Roux renouvelle son accusation en nommant le propriétaire du chai. "Il expose, dit la relation publiée à l'époque, les principaux caractères de l'étrange maladie qui sévit à Hyères en ce moment, et s'élève contre l'opinion de ceux qui prétendent qu'elle n'est autre chose que la grippe." Il y a eu, en effet, ajoute-t-il, quelques cas de grippe dans notre ville, mais aucun d'entre eux n'a été observé sur des personnes ayant bu

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des vins de M. X..... Quant aux personnes qu'il traite pour la maladie dont il vient de faire la description, toutes ont usé de ces vins, et c'est à eux seuls qu'elle doit être attribuée. Il termine en demandant à ses collègues s'ils ont observé des symptômes semblables à ceux qu'il a constatés.

Cette manière de voir fut appuyée par le Dr Vidal. Il déclara partager absolument les idées émises par son honorable collègue, le Dr Roux. "Depuis quelques temps, dit-il en effet, les nombreux symptômes de l'acrodynie signalés par les auteurs ont été observés dans la population..... En présence des déclarations de M. Charles Roux, et considérant que l'acrodynie est toujours le résultat d'un état particulier de l'organisme, produit par des aliments de mauvaise qualité, il demande qu'il soit nommé dans le sein du Comité d'hygiène une commission de trois membres chargée de faire une enquête sur les faits développés par M. le Dr Roux." (*Hyères Journal*, 29 avril 1888.)

Cette mesure fut adoptée à l'unanimité. En même temps des échantillons du vin suspect avaient été envoyés pour l'analyse chimique à M. le Dr Sambuc, à Toulon. Le 17 avril, M. Roux recevait de lui une première communication mentionnant qu'il avait trouvé dans certains échantillons jusqu'à 8 centigrammes d'acide arsénieux par litre. Désormais la phase médico-légale va commencer.

La première phase, la seule qui nous intéresse et dont nous avons relaté brièvement les péripéties, va du mois de fevrier au 4 avril; les cas, peu nombreux d'abord, augmentent au point d'éveiller l'attention de l'autorité.

Diverses opinions plausibles sont formulées jusqu'à l'époque à laquelle l'intervention du Dr Roux est décisive. C'est précisement pendant cette phase d'étonnement et d'incertitude qu'ont été observés les phénomènes cliniques les plus frappants de l'intoxication.

Comme de pareils faits sont rares, nous allons les passer en revue.

Ceux qui attirèrent surtout l'attention furent :

1° Des troubles digestifs;

2° Des éruptions cutanées;

3° Des phénomènes nerveux assez prononcés pour faire songer à une affection médullaire.

Les troubles digestifs, malgré leur fréquence, furent moins importants qu'on ne serait, *a priori*, tenté, de le croire. Le malade de M. Vidal était venu réclamer ses soins pour un embarras gastrique; sous l'influence dutraitement les nausées et les douleurs épigastriques disparurent, mais à ce moment survint une diarrhée qui durait encore quinze jours plus tard. M. Marques note la rareté des vomissements et fait remarquer qu'il y a de la diarrhée dans presque tous les cas. Avant et après la découverte de la cause du mal, M. Dubrandy soigne soixante-trois personnes intoxiquées qui ont présenté des éruptions cutanées ou des phénomènes nerveux. Chez huit, il n'y a eu ni vomissements ni diarrhée, mais seulement de l'inappétence et des nausées. Le même observateur a noté encore le ptyalisme avec sensation pénible de constriction rétro-sternale et épigastrique. M. Vidal parle de la présence de plaques rouges sur la muqueuse du voile du palais et celle du pharynx.

Il est difficile de donner des notions précises relativement à l'époque de l'apparition et à la forme la plus fréquente des manifestations cutanées. Tantôt, c'était un symptôme initial (du moins c'était à cause de lui que les malades s'adressaient au médecin) qui existait en même temps que les troubles digestifs; d'autres, fois, les exanthèmes ne se montraient qu'après l'apparition des paresthésies des membres; enfin, dans certains cas, lorsque la plupart des autres phénomènes étaient rétrocédés, les éruptions tardives furent les plus opiniâtres.

S'il on voulait donner un nom adapté exactement à la forme de toutes ces éruptions, il faudrait épuiser la nomenclature dermatologique actuelle. Les taches se superposent et se remplacent sans qu'il soit possible de fixer de règle à propos de leur évolution. Le malade de M. Vidal a d'abord des plaques d'urticaire qui sont le siège d'un prurit pénible.

Le lendemain, l'aspect change; on voit poindre entre elle des taches d'une nouvelle forme, qui, au bout de quelques heures, rappellent à s'y méprendre celles de l'éruption rubéolique; elles subissent une desquamation assez rapide, et se résolvent en une sorte de poussière épidermique très fine. Tout n'est pas fini. Un autre exanthéme à macules saillantes, de couleur café brûte, se montre en différents points du corps, après avoir débuté aux jambes. La desquamation totale de la plante des pieds et de la paume des mains devient imminente; un sillon d'aspect cuivré indique la limite précise jusqu'à laquelle elle se feva. Dans un cas de M. Dubrandy, l'ongle d'un orteil tomba et ne tarda pas à se reproduire. Au milieu de ces éruptions confuses, deux méritent une mention particulière. Un malade de M. Marquez, un homme de soixante-sept ans, dont nous aurons l'occasion de dire un mot, eut une ulcération du gland qui ressemblait à s'y méprendre à un chancre. M. Dubrandy mentionne des plaques du couleur cuivrée et à contour circiné, ressemblant au psoriasis syphilitique. Plusieurs de ces éruptions durèrent longtemps, certaines n'étaient même pas guéries à l'époque où les travaux ont été adressés à l'Académie. MM. Marquez et Dubrandy ont noté dans un cas, sur le rebord gingival, la présence d'un liséré semblable à celui de l'intoxication saturnine.

Les accidents nerveux ont été les plus importants; c'est, comme nous l'avons vu, en tenant compte de leur modalité que M. Vidal est arrivé à songer à l'acrodynie.

En général, ils débutaient par une diminution de la puissance des muscles servant à la station et à marche (muscles pelvi-trochantériens et des membres inférieurs); les malades étaient fatigues, ils avaient un peu de difficulté dans les mouvements, puis la sensation s'accentuait, leurs jambes devenaient pesantes; ils ne marchaient plus que le tronc incliné en avant, en titubant comme s'ils avaient eu de la peine à détacher leurs pieds du sol et à reprendre l'équilibre à chaque pas qu'ils faisaient. Ils s'avançaient les jambes à moitié fléchies; la pointe des pieds trainait et butait. D'autres malades s'affaissaient inertes sur eux-memes, lorsqu'ils essayaient de se mettre debout, et pourtant tous les mouvements des jambes étaient possibles dans le décubitus dorsal. La contractilité électrique des muscles était intacte. Il y avait des contractions, des tressaillements, surtout dans les mollets.

Il existait des troubles de la sensibilité en même temps que des troubles de la motilité; les premiers persistaient souvent après les seconds et avaient une ténacité désespérante. La sensibilité à la pression était amoindre; certains malades ne sentaient plus le sol et pourtant accusaient des fourmillements, des douleurs intermittentes, fulgurantes, surtout la nuit; il le caractérisaient par des comparaisons pittoresques telles que celle-ci: "des chiens me rongent la peau des mollets et de la plante des pieds": parfois les paresthésies étaient plus étendues, presque généralisées; il y avait de la céphalalgie, des points pleurodyniques; un enfant de neuf ans se plaignait qu'il avait des papillons dans les dos. Les diminutions et les modifications de la sensibilité s'accompagnaient d'une hyperesthésie cutanée trés pénible. Nous avons vu que le contact des draps ne pouvait être supporté par l'un d'eux.

Les altérations de la sensibilité speciale furent moins constantes. Pourtant le toucher fut souvent émoussé; un malade ne pouvant sentir sa plume *écrivant*, a-t-on dit, *avec le bras*; par suite d'une circonstance analogue, un enfant dut cesser momentanément de fréquenter l'école. L'audition fut peu altérée. M. Dubrandy a signalé des désordres oculaires de différente nature qu'il met sur le compte de l'empoisonnement: ainsi, chez trois couturières, la diminution de l'acuité visuelle fut telle qu'elles cessèrent de pouvoir travailler; à l'ophtalmoscope il constata une hypérémie retinienne assez marquée; l'amblyopie finit cependant par disparaître. Le même auteur croit également qu'une double cataracte à développement rapide avait eu une origine identique; ce qui rend cette opinion vraisemblable, c'est qu'un trouble du cristallin observé dans les mêmes conditions n'alla pas jusqu'à l'opacité et cessa en même temps que les autres symptômes (Dubrandy).

Chez plusieurs individus, on a noté une impuissance sexuelle qui a duré plusieurs mois.

Pour avoir le tableau complet, il faudrait ajouter aux phénomènes que nous venons d'énumérer et qui demeurent la scène, d'autres manifestations moins fréquentes peut être, mais parfois aussi importantes que les premières et capables de créer une physionomie propre à un cas donné. C'est d'abord un catarrhe bronchique contemporain des exanthèmes, assez intense pour avoir produit quelquefois une dyspnée inquiétante; c'était, selon toute probabilité, une détermination morbide comparable à celle qui avait lieu sur la peau. Ce catarrhe s'accompagna de coryza, d'injection conjonctivale et, dans uncas, d'exophtalmie; il a souvent plus éprouvé le malade que les troubles digestifs; son existence permet de supposer, comme l'a cru M. Marquez, que bon nombre des grippes développées vers la fin de l'hiver n'étaient en réalité que des déterminations anormales. Viennent ensuite les œdèmes partiels

(bouffissure des paupières et de la face, enflure autour des genoux et des malléoles), l'amaigrissement, la glycosurie transitoire notée par M. Vidal.

Il resulte de ce que nous venons de voir que les ingestions répétées de doses dissemblables, mais relativement élevées, d'arsénic n'ont été suivies que d'accidents peu importants correspondant à la période d'absorption ; les plus sérieux se sont montrés pendant la diffusion dans l'organisme et surtout l'élimination. Jamais probablement ils n'ont occasionné la mort. Onze personnes ayant bu du vin venant de la cave dangereuse avaient succombé pendant la période des empoisonnements. Par ordre de l'autorité, les cadavres furent exhumés et soumis à l'autopsie medico-légale. Trois fois seulement on trouva de l'arsénic et deux fois une dose capable d'occasioner la mort : les cadavres appartenaient à un phtisique arrivé au dernier degré de la maladie, et a un diabétique qui depuis assez longtemps avait une quantité considérable de sucre dans les urines. Ni les experts, ni les médicins traitants n'attribuèrent la terminaison funeste à l'acide arsénieux.

Fait curieux, cette substance paraît avoir exercé une ou deux fois, malgré les bizarreries du mode d'administration, un effet thérapeutique : un homme de cinquante-cinq ans, soigné par M. Marquez pour un asthme a accès fréquents, n'en eut plus depuis l'apparition des parésies d'intoxication ; un vieillard de soixante-sept ans, dont nous avont déjà parlé, a été débarrassé d'accidents goutteux lui rendant depuis plusieurs années la marche impossible. Si satisfaisants que soient ces résultats, nous ne songeons pas un recommander aux partisans la méthode de traitement qui les a donnés.

Reste une question. M. Vidal a parlé d'acrodynie et cela avec beaucoup de sens clinique. Peut-on accepter son idée et se servir de l'épidémie d'Hyères, pour en expliquer d'autres restées comme autant de problèmes non résolus dans l'histoire de la pathologie ? Ce serait une éventualité désirable. Les épidémies en question ne se perdent pas dans les brumes du moyen âge ; on n'est pas obligé pour les connaître de faire un long travail d'archéologie et d'exégèse sur des chroniques naives et mensongères ; elles ont été étudiées par nos maîtres, par les médecins, les plus instruits du temps ; elles sont presque contemporaines, et, malgré cela, nous sommes obligés de faire l'aveu désobligeant que nous ne savons ni quelle était leur nature, ni ce qui les produisait. Peut-on, après les épisodes du Midi, déclarer ces épidémies étaient une forme d'arsénicisme due, selon toute probabilité, a l'addition d'acide arsénieux à des matières alimentaires ?

Je ne le crois pas. Sauf dans l'épidémie observée pendant la campagne de Crimée, le processus clinique fut notablement différent A Hyères, les phénomènes gastro-intestinaux n'ont existé que pour mémoire ; s'il n'y avait eu qu'eux, les malades les auraient supportés sans se plaindre et probablement les médecins n'auraient jamais songé à faire d'enquête.

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Dans les acrodynies de Paris, de Meaux, de la Ferté-Gaucher, de Coulommiers, il y a eu des diarrhées rebelles, opiniâtres, absorbant encore l'attention à l'époque des parésies : des diarrhées cholériformes et dysentériformes. La seule différence dans la manière dont ce symptôme se comporta ne permet guère d'assimiler les acrodynies d'il y a soixante ans à l'arsénicisme. Puis, il y a, dans celles-là, des bizarreries de diffusion. La maladie d'Hyères est restée cantonnée dans la zone où l'on débitait la denée toxique ; l'acrodynie sautait d'un quartier à l'autre, d'un département à l'autre, et aucune relation commerciale ne pouvait expliquer ces particularités, De plus, il y eut enquêtes sur enquêtes. On connaissait l'empoisonnement par l'arsénic à peu près aussi bien qu'on le connaît aujourd'hui. Tout fut scruté, examiné ; les soldats qui ne buvaient pas de vin étaient malades, et les civils qui en buvaient dans le voisinage ne l'étaient pas ; le pain des quartiers de Lourcine ou du Faubourg-du-Temple ne valait ni plus ni moins que celui des quartiers voisins. Jamais, nulle part un fait typique comme celui qui mit le Dr. Roux sur la voie (arsénicisme chez le mari qui boit du vin, immunité du reste de la famille qui n'en boit pas) n'a été constaté. Malgré des similitudes indiscutables, nous ne trouvons pas dans l'évolution et la nature de la maladie d'Hyères une explication qu'on puisse adapter intégralement aux épidémies d'acrodynie, et nous en restons aux conjectures de nos devanciers. C'étaient probablement des maladies d'alimentation, mais on ne sait à quel produit rattacher les accidents qui les caractérisèrent.

Quoi qu'il en soit, les études que nous avons eu l'occasion de parcourir et que nous venons d'analyser sont intéressantes par l'importance des observations et la justesse des aperçus qu'elles renferment. Votre rapporteur a donc l'honneur de vous proposer d'adresser aux auteurs, MM. les Dr Vidal, Marquez et Dubrandy, les remerciements de l'Académie.

Bien, que M. Roux n'ait envoyé aucune communication à l'Académie, votre rapporteur croirait être injuste en ne rappelant pas aussi la grande part que cet observateur a eue dans la découverte de la véritable cause de l'épidémie qui a frappé la population d'Hyères.

Les conclusions du présent rapport, mises aux voix, sont approuvées par l'Académie.

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NOTE on Administrative questions arising out of the recent Epidemic, by Dr. CAMPBELL BROWN (Q. 6938).

If recent events are followed by legislation, it seems undesirable to legislate for beer alone, which will be well looked after now that it is known to be liable to contain arsenic, and to leave out of account all the other things, known or unknown, which are liable, or will in the future be liable, to be in some way contaminated with other things. Any new legislation should aim at securing immunity from contamination for all kinds of food and drink.

As regards Arsenic in Beer.—Considering the fact that the use of arsenical glucose was the result of combined ignorance and carelessness, that it was immediately stopped when discovered, and that it is not likely to ever occur again, and considering also that arsenic is exceedingly likely to get into beer from malt, and that, in fact, minute traces are very seldom absent, it would be vain to prohibit the use of glucose and invert for the purpose of preventing arsenication of beer. The question of permitting or prohibiting the use of sugars must be settled on entirely different grounds.

I suppose the Inland Revenue officers can deal at present with both glucose and malt; the local inspectors under Sale of Food and Drugs Act can do so, but they can only take samples as they are delivered to the brewer, and with his consent. They cannot go to the malster or his coke merchant, nor to the sulphuric acid maker; nor could they take samples of coke or of sulphuric acid even as they are delivered to the maltster or glucose maker. They ought to have this power.

Necessity for Standards of Arsenic.—Before going further on the subject of legislation I ought to mention another point as regards arsenic.

Arsenic is everywhere in more or less minute traces. The air of towns, yeast, malt, beer, bread, everything containing or made with soda, and so on, contain minute traces. These traces are usually negligible, and are neglected. They are called nothing quite properly, and articles containing them are called pure.

That is right, but the traces exist, and the question must arise, At what point does the negligible quantity and the important quantity meet?

It is useless to say no arsenic should be present. It must and will be present, and can be detected if sufficiently large quantity of sample is examined. It would be impracticable to prohibit any trace of arsenic alike in malt and in sulphuric acid and in other things.

The question of standards cannot be got rid of. Unless the Legislature provides some simple and efficient means of fixing the standard of arsenic and other things there will be a great deal of useless litigation and great want of uniformity. One analyst will give a common-sense opinion, that such-and-such a quantity is of no consequence, or is not more than is usual or inevitable. Another will say of a quantity so small as to be quite indeterminable with any approach to precision, although it can be detected with certainty, that it is "deadly poison," although he has probably a larger quantity in his own body at the time, he being in perfect health. The courts will give varying decisions, and no one will know what to do. No state of things could be worse for trade and the public.

Similarly with sulphuric acid. No maker will guarantee that his acid is absolutely free from any trace of arsenic. It is most difficult to get even a small quantity of sulphuric acid absolutely free. But any manufacturer will guarantee that his acid is purified down to any absolutely safe limit which can be reasonably fixed.

After giving much thought to the consideration of possible legislation, I venture to express the opinion that legislative machinery is needed in the following directions:—

A.—Duties of Manufacturers.

1. To make it compulsory for manufacturers to test every bulk or batch sent out of any article which is to be used in the preparation, manipulation, conveyance, or storage of any food, for any impurity which would "impair the wholesomeness of such food." (*See* Fertilisers and Feeding Stuffs Act.)

Manufacturers to be presumed to know the use to which the thing he sells is put, unless he shows that he could not reasonably be expected to find out.

2. To enact that if the article is sold for use in the preparation, treatment, conveyance, or storage of any food, then shall be implied a warranty that such article is free from all ingredients which would impair or injuriously affect the wholesomeness of such food.

3. Manufacturers buying any such article for the preparation or treatment, etc., of food, should be required—

(*a*) To inform the vendor of the purpose for which he wants the article.

(*b*) To check the purity of each bulk or batch delivered.

B.—Powers under Sale of Food and Drugs Acts.

4. The Sale of Food and Drugs Acts should be extended so as to give power (*a*) to Inland Revenue or other Local Government Board officers, and (*b*) to inspectors for local authorities, to take samples of and to trace back to the manufacturer or to its original source (even out of the inspector's own district) any article used in the preparation or manipulation, etc., of any food or drug (using the definition of food in the Act of 1899), taking samples at each or any stage, and to have the samples analysed to ascertain whether (1) and (3) have been efficiently complied with, and to prosecute if occasion arises.

C.—Regulations by Government Department.

5. To authorise the Local Government Board when desirable or necessary, or when called upon to do so, to make regulations after inspection and inquiries, fixing a standard quantity of any specified ingredient in any specified article of food or article used in the preparation of food, above which the article shall be presumed to be impure, and below which the said article shall be presumed to be genuine.

For example, a regulation might prohibit the use of more than 4 per cent. of lead in the metal for siphon lemonade, etc.

To specify a standard quantity under this fifth provision would be far more satisfactory and workable than the provision so often recently suggested that the legislature should prescribe a standard mode of testing. The idea underlying the latter suggestion is that a test should be so designed and carried out as to fail to detect a small quantity (of arsenic, for example) which might be considered passable, and which would at the same time *easily* detect penal quantities. Any such test would be most variable in practice, and lead to confusion. No two men would get the same result from the same sample. In respect of arsenic, the suggestion means that either Marsh's test—a most inexact and unreliable test in practice—or Reinsch's test—a good qualitative test—should be so conducted as to have an approximimate quantitiative value; and that this approximate value should have a legal compulsory recognition. To legalise a variable quantity would be foolish and disastrous. Either of these tests gives results which not only vary with the mode of working (which by hypothesis would be fixed by enactments), but vary also with the operator, with the circumstances and condition of the article, and the other things with which it is mixed.

The only rational standard for legislation to fix is an absolute standard of so much actual arsenic which can be determined by weighing or other exact means. This real quantity being fixed, then if any individuals or firms choose to take the short approximate way of ascertaining the quantity which they may find sufficiently reliable in the hands of their own chemists, they would be at liberty to trust to that mode of testing at their own risk; but the ultimate appeal would always be to the balance or some equally precise determination, and not to any method which is at best only a method of more or less happy guessings.

In fixing standards regard should be paid to what is practicable in working the Acts, and practicable for the manufacturer, and practicable for the inspector and analyst.

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EPSOM SALTS:

Used for hardening brewing water (Briant), 7226–8. Arsenic in (Briant), 7226.

EXPERT COMMITTEE:

Appointed by Manchester Brewers' Association (Salamon), 1244–9; (Groves), 1551. Members of (Salamon), 1246. Work by and reports (Salamon), 1250–1260, and Appendix No. 5; (Luff), 2901–5; (Stevenson), 2220; (Brunton), 5942. Tests advised (Salamon), 1318–1329. Further work in progress (Salamon), 1335; (Luff), 2987.

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Arsenic in (Mann), 3734.

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Use of, in beer (Briant), 7246–7267. May be cut by tartaric acid (Briant), 7246–7254, or by sour beer (Briant), 7258–7264. Outside London sediment after fining remains in cask (Briant), 7255.

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FOODS AND DRINKS (OTHER THAN BEER) IN RELATION TO ARSENIC:

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BAKING POWDERS: Liability to contain arsenic (Kirkby), 3704–6.

CLARET: Use of glucose in (Wahl), 7442–5.

COLOURED CONFECTIONERY: No arsenic recently found in (Stevenson), 2478. No arsenic found in (Jones), 1788–1791.

DRIED APPLES: (Stevenson), 2341–2351.

GOLDEN SYRUP: No arsenic found in (Jones), 1777–1780.

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HAMS: Smoked hams (Stevenson), 2356.

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REFINED SUGAR: Traces of arsenic in (Hehner), 7924–6, 7984–7990.

SHRIMPS: Arsenic in potted shrimps, due to borax (Delépine), 5317.

SWEETS, JAMS ETC.: No arsenic found in (Stevenson), 2475–7; (Sergeant), 4129; (Niven), 529–534; (Hope), 912–5; (Jones), 1780; (Bell), 4488–4490

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VEGETABLES GROWN ON ARSENICAL SOIL: May contain arsenic (Stevenson), 2309–2313.

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See also PROSECUTIONS, PUBLIC ANALYSTS, OFFICAL CONTROL.

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Arsenic in (Jones), 1823–1833; (Delépine), 5247; (Earp), 7100. Arsenic in malt mainly attributable to (O'Sullivan), 5754. No arsenic found in some coke-dried malts (Tomson), 3128–3137.

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GAUTIER, M.

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MALT:

ARSENIC IN MALT:

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PREPARATION OF:

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See also FUELS. GUARANTEES.

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See also EPIDEMIC, FOOD AND DRUGS ACTS, OFFICIAL CONTROL.

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Parts per Million.	Equivalent to Grains per Gallon.	Equivalent to Grains per lb.
048	·0033 = $\frac{1}{300}$	·0003 = $\frac{1}{3000}$
·05	·0035	·00035
·057	·004 = $\frac{1}{250}$	·0004
·064	·0045	·00045
·071	·005 = $\frac{1}{200}$	·0005
·083	·0058	·00058
·095	·0066 = $\frac{1}{150}$	·00066
·1	·007	·0007
143	·01 = $\frac{1}{100}$	·001 = $\frac{1}{1000}$
·177	·0124	·00124
·19	·013 = $\frac{1}{75}$	·0013
·22	·015	·0015
·286	·02 = $\frac{1}{50}$	·002
·39	·027	·0027
·476	·033 = $\frac{1}{30}$	·0033 = $\frac{1}{300}$
·5	·035	·0035
·571	·04 = $\frac{1}{25}$	·004 = $\frac{1}{250}$
·714	·05 = $\frac{1}{20}$	·005 = $\frac{1}{200}$
·893	·062 = $\frac{1}{16}$	·0062 = $\frac{1}{160}$
1·0	·07	·007
1·19	·083 = $\frac{1}{12}$	·0083 = $\frac{1}{120}$
1·43	·1 = $\frac{1}{10}$	·01 = $\frac{1}{100}$
1·79	·125 = $\frac{1}{8}$	·0125 = $\frac{1}{80}$
2·38	·166 = $\frac{1}{6}$	·0166 = $\frac{1}{60}$
2·86	·2 = $\frac{1}{5}$	·02 = $\frac{1}{50}$
3·57	·25 = $\frac{1}{4}$	·025 = $\frac{1}{40}$
4·76	·33 = $\frac{1}{3}$	·033 = $\frac{1}{30}$
7·14	·5 = $\frac{1}{2}$	·05 = $\frac{1}{20}$
9·52	·66 = $\frac{2}{3}$	·066 = $\frac{1}{15}$
10·7	·75 = $\frac{3}{4}$	·075
14·29	1·0	·1 = $\frac{1}{10}$
21·43	1·5	·15
25·0	1·75	·175
28·57	2·0	·2 = $\frac{1}{5}$
35·71	2·5	.25 = $\frac{1}{4}$
42·86	3·0	.3

I.—Table of Equivalents, &c.—*continued.*

Parts per Million.	Equivalent to Grains per Gallon.	Equivalent to Grains per lb.
71·43	5·0	·5
142·87	10·0	1·0
214·29	15·0	1·5
285·71	20·0	2·0
357·14	25·0	2·5
428·57	30·0	3·0
571·43	40·0	4·0
714·29	50·0	5·0
857·14	60·0	6·0
1000·0	70·0	7·0

II.—MISCELLANEOUS.

1 gallon = 8 pints = 4·54 litres = 4,540 c.c.

1 gallon water weighs 10 lbs. = 70,000 grs. = 4,540 grammes.

1 pint = ·567 litre = 567 c.c.

1 litre = ·22 gallon = 1·76 (say 1¾) pints.

1 litre water weighs 1,000 grammes = 2·2 lbs. = 35¼ ozs.

100 c.c. = ·022 gallon = ·176 pint (say ⅛ pint).

A barrel of beer = 36 gallons = 163·44 litres.

A quarter of malt = 8 bushels = 8 × 42 lbs. = 336 lbs.

Percentage of Glucose (or other brewing sugar) means the weight of glucose per cent. of the total materials (malt plus glucose, &c.) used.

Equivalent of Glucose (or other brewing sugar) *to Malt.*—For Excise purposes 28 lbs. of cane sugar, or 32 lbs. solid glucose or saccharum, are deemed equivalent to 1 bushel (42 lbs.) of malt.

Priming.—Excise allows priming up to 1½ per cent. by volume (or half-gallon per barrel) of a syrup of specific gravity not exceeding 1,150.

To ascertain weight of sugar corresponding to a given quantity of priming solution, divide the excess degrees of specific gravity above 1,000 by 38·6; result is lbs. of sugar per gallon of priming solution.

Thus the maximum weight of sugar allowed as priming per barrel (half-gallon) would be $\frac{1}{2} \times \frac{150}{38·6} = 1·94$ lbs.

This maximum, 1·94 lbs. per barrel, is equivalent to the addition of ·054 lb. priming sugar per gallon of beer.

ROYAL COMMISSION

ON

ARSENICAL POISONING

ARISING FROM THE CONSUMPTION OF BEER AND OTHER ARTICLES OF FOOD OR DRINK.

MINUTES OF EVIDENCE AND APPENDICES.

VOL. II.—Evidence received in 1902-3,

TOGETHER WITH

Appendices 16 to 32, and Index.

(BEING PART II. OF THE FINAL REPORT OF THE COMMISSION).

Presented to both Houses of Parliament by Command of His Majesty.



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1903.

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MINUTES OF EVIDENCE

TAKEN BEFORE THE

ROYAL COMMISSION

ON

ARSENICAL POISONING

(VOLUME II.)

NINETEENTH DAY.

AT WESTMINSTER PALACE HOTEL.

Friday, 7th March 1902.

PRESENT:

The Right Hon. Lord KELVIN (*Chairman*).

Sir WILLIAM CHURCH. | Dr. WHITELEGGE.

Dr. BUCHANAN (*Secretary*).

Dr. ERNEST S. REYNOLDS, recalled; and Examined.

Dr. E. S. Reynolds.

7 Mar. 1902.

8287. (*Chairman.*) We had the great benefit of evidence from you in the early part of this Inquiry, and we should like now to hear what further information continued researches of your own enable you to give?—Since I was here last I have been looking out, of course, extremely carefully, for what has been happening in the case of patients with neuritis, not only at the Poor-Law Infirmary at Crumpsall, but also among out-patients at the Manchester Royal Infirmary, and I may say that I have had a great opportunity of seeing a large number of patients. As regards the arsenical symptoms, I am able to state that they have practically now all disappeared in Manchester—there are no longer any of keratosis, there are none of true arsenical neuritis, and there is no arsenical pigmentation to be seen.

8288. That is patients at the Manchester Royal Infirmary out-patient department and also at the Manchester Workhouse Infirmary? What you say applies to patients in both those institutions?—Yes, to the whole of the Manchester district. And I would also say that so-called "alcoholic" dilatation of the heart has also almost entirely disappeared from the Manchester district. Herpes has likewise very much diminished, and even the pigmentation which one used to so commonly associate with patients with vermin on them has much diminished. It still occurs in very dirty patients, but it has also much diminished.

8289. When it occurs in very dirty patients you do not think the pigmentation is arsenical?—This pigmentation used to be supposed to be always due, in the pauper class, to the presence of vermin, and we used to see a very great deal of it. We see some of it still, but nothing like to the same extent, which looks as though some of it, at any rate, formerly was related to arsenic. It has not all disappeared, but it has very much diminished even with those patients.

8290. Can pigmentation due to vermin be mistaken for arsenical pigmentation?—It is almost exactly the same to look at.

8291. By external appearance?—Yes.

8292. Have you any means of distinguishing by close washing or any examination of the skin?—I do not know of any at all. I do not think it could be distinguished; it is practically the same kind of pigmentation. Then in June and September of last year we did see a few cases with arsenical symptoms, but on inquiry we always found that these were patients who had been affected during the epidemic itself. In July I saw two women who said they had not been affected during the epidemic, but the hair of both of these women, examined by Professor Dixon Mann, was shown to contain considerable quantities of arsenic, and the beer that one of them had been drinking even in September contained one-hundredth of a grain of arsenic per gallon. Of course, that is comparatively speaking nothing—a very small amount.

8293. It appeared there was arsenic in the hair?—Yes, that was present in both of these women.

8294. We hope to have some information from you on that subject later. But first can you tell me if arsenic appears in the pigmentation? Is the substance arsenic found in the pigmented skin?—I believe not, my Lord. It is not arsenical.

No arsenic in pigmented skin;

8295. That, of course, could not be examined generally except after the post-mortem?—Not easily, but I think it has been examined, and that is not arsenical. That is really one of the ordinary skin pigments such as you get in the negro.

8296. In scurf rubbed from the skin of pigmented patients is arsenic found?—It is found in the scales of skin that are given off when the skin scales, as it does in many of these cases of keratosis, for instance. Arsenic has been found in the scales.

but found in scales in keratosis, &c.,

8297. Especially from the scales coming from the parts where there is pigmentation?—Not necessarily; no. It has been found more on the scales from the feet and the hands. On the palms of the hands and the soles of the feet there is no pigmentation, and yet the scales from these contain a considerable quantity of arsenic in arsenical cases.

8298. And the nails both of the fingers and feet?—Those, again, have been found to contain arsenic.

and in nails,

8299. Have you any measured quantities of arsenic which have been determined in the hair?—No, my Lord,

and hair,

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Dr. E. S. Reynolds.
7 Mar. 19 2.

I have not. examinations of hair have been done, and the results simply returned to me as "considerable quantities" or "traces,' but I have not any definite amount at all. These examinations of hair have been nearly all done by Professor Dixon Mann.

8300. Have you yourself any knowledge of arsenic in the hair of people taking no arsenic?—It is a difficult thing to say that they are taking no arsenic. I have some analyses of hair which Mr. Scudder, the chemist in Manchester, gave me yesterday, and it contains minute traces of arsenic—something like, I think, 1-100th of a grain in two grains of hair.

8301. The 100th of a grain of arsenic?—Yes, in two grains of hair.

8302. That is 1-200th of the weight of the hair?—I have his figures here somewhere.

8303. That would be enormous?—No; it is ·005 per cent.

8304. That is 1-300th per cent., or 1-30,000th of the weight?—Yes.

8305. That was in the hair of a healthy person not known to have been taking arsenic in any way?—Yes.

8306. Is the inquiry so far advanced that we can say that arsenic may usually be found in the hair or in the beard of ordinary healthy people?—In some cases, certainly, but not in all. In some cases it is certainly found in apparently healthy people.

Gautier's statement as to arsenic in thyroid.

8307. You know, no doubt, the investigation of the French chemist, Gautier, in which arsenic in considerable proportion is found in the thyroid gland of healthy human beings, men and women?—I know all those researches.

8308. May we consider it proved that arsenic is an essential ingredient in the thyroid gland?—No, my Lord, I should not like to bind myself by Gautier's researches.

8309. Does Gautier's investigation go so far as to say that it is found in every case, or that he found it in certain cases, and did not find it in others?—I think he wished to make out that it was practically a normal constituent; but knowing what we do now of the prevalence of arsenic in all sorts of things, I think it is quite possible it got there from outside sources into the body in the cases he examined.

8310. (*Sir William Church.*) I should like just to clear up one point with regard to the presence of arsenic in the thyroid gland. What would be your opinion on that? Would it be probable or improbable that arsenic might remain locked up in the thyroid gland for a long time if it once got there?—I should think that it is extremely probable it would do, because it is a gland, of course, which has no duct, and I should think it is very likely it might get locked up in the tissues there.

8311. Do you know anything about the constitution of the thyroid gland—whether there is any affinity of any of the tissues, or their excretions, for arsenic? Can you express an opinion about that?—I should not like to express an opinion about it, but I know Professor Dixon Mann has been examining the thyroid gland, and he has not found arsenic, and, of course, he is a most thoroughly reliable observer.

8312. (*Chairman.*) He has not found arsenic?—No, my Lord. I think the experiments of Gautier ought to be taken certainly with some reserve until they are confirmed.

8313. (*Sir William Church.*) Supposing a person had either medicinally or in some way taken arsenic a considerable time before the thyroid gland was examined, you think it is not improbable that traces of arsenic might be found in it?—I think it is extremely likely, and especially as it strikes one the thyroid gland is probably the only place where iodine is found as far as I know in the body, which is not very far distant, of course, from arsenic.

8314. And it is yet an open question whether arsenic is or is not an essential ingredient of the hair?—I do not think it is an essential ingredient, because of the number of blank results that have been obtained. Some of those results I can give you in a few moments in speaking of beri-beri.

Sufferers from epidemic still under treatment, 1902.

8315. Have you any patients left at Crumpsall still suffering from paralysis?—Yes, two, and these are gradually recovering. Those are the only two. We have had altogether at Crumpsall from November 30, 1900, to July 20, 1901, thirty deaths; seventeen were women and thirteen men. Of those ten men and four women were also found to be suffering from rapid consumption. Of course, these cases do not include those which may have died before the cause of the outbreak was known. That is only from November until July. It is extraordinary the number of these cases that have died of consumption—a very large proportion—ten out of the thirteen men and four out of the seventeen women.

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Tuberculosis among epidemic cases.

8316. (*Dr. Whitelegge.*) Was consumption of recent origin in these cases?—That one cannot say; one finds often old consumption in these pauper cases; but it certainly looks as if it had been wakened up. Another interesting point, medically at any rate, is that the ascites in these cases, which is generally supposed to be due to liver disease, we found to be due to tubercular peritonitis in a very large number of cases.

8317. Tubercular peritonitis is included in what you call consumption?—Yes.

8318. (*Sir William Church.*) Just merely to make what you said to Lord Kelvin quite clear, the pigmentation that you observed both during the period that arsenical poisoning was going on and also since, has been generally situated on those parts of the body which are most subject to pigmentation?—No, I do not quite think so. It has not been the pigmentation situated in the same places as Addison's disease. That is to say, during the whole epidemic the face was fairly free. The pigmentation was more on the body, beginning, if anything, below the neck.

Sites of pigmentation.

8319. With the exception perhaps of around the eyes, the face is not the place in which you get usually pigmentation from other causes than Addison's disease?—I see what you mean. That is so, exactly. But, of course, in a person exposed much to the weather you get more pigmentation on the face normally.

8320. Normally, yes; but in most arsenical cases the pigmentation has been in the axillæ, the groins, and in these parts of the body in which pigmentation generally occurs, from whatever cause it may be?—Certainly.

8321. Since 1901, your experiences of neuritis, and of other changes which have been referred to arsenic in Manchester, have approximated to the experiences of other large towns?—I should imagine so, yes.

Rarity of "alcoholic neuritis" apart from arsenic.

8322. You still have met with cases of peripheral neuritis attributable to alcohol?—That brings me to the next point. During this period of course I have seen in hospital work, and also in private, a considerable number of very heavy drinkers, and during this time, in the last nine months, I have only seen two cases, and those were both in private, where there were symptoms of neuritis—two isolated cases. One was a cab driver, who drank at least a bottle of whisky a day; and another was a lady that I saw only about a fortnight ago, who was also drinking, as far as we could make out, at least a bottle a day. In both these cases there were signs of neuritis. In the cabdriver there were pains in the limbs. There was some loss of power, but there was no wasting, and there were no other signs at all of any arsenical poisoning, and I do not think that he took beer. I went very carefully into the case, and I think his statement that he always took whisky was quite true. The lady was bed-ridden, and certainly took no beer. She took whisky only. In her case the symptoms were coming on rather fast. There was some wasting; there was distinct loss of power, although she could walk, and there were marked pains in the limbs. Again, there was not a single sign of any other arsenical symptom. So that these two cases—and there have been only two in all the enormous number of alcoholics I have seen during the last twelve months—these are the only two cases I have been able to pick out in which beer drinking could be excluded absolutely, and, at the same time, in which there were signs of peripheral neuritis. So that, personally, my own opinion is that alcohol will cause peripheral neuritis, but that, considering the large amount of spirit taken by various people in this country, it is certainly one of the rarest diseases if unassociated with arsenic. In pure beer drinkers there is now no peripheral neuritis in Manchester. It has all gone; it has entirely disappeared. You never see a case in the hospital, and this is not only my experience, but it is the experience of Dr. Dreschfeld, Dr. Bury, and others. And I should like to add that Dr. Graham Steell has also told me that he has not lately been able to find any cases of "alcoholic dilatation of the heart," which he had previously written upon to a large extent, and which for many years—not merely during 1900—was common in Manchester.

None in beer drinkers.

Disappearance of "alcoholic heart" in Manchester.

8323. (*Dr. Whitelegge.*) These "alcoholic hearts," which have now disappeared, were found in considerable numbers?—Yes.

8324. Did they occur in heavy drinkers only?—Yes, I think so, speaking from my own experience, of course; heavy beer drinkers.

8325. Did they occur apart from neuritis or pigmentation?—Some of them did, but most of them, if carefully examined, had neuritis.

8326. Have you any records of this condition of heart occurring apart from alcohol—from arsenic derived from other sources than beer?—I have not; but in the cases reported—in Brouardel's cases at Havre—the same condition occurred. I think it was in this Havre outbreak, where the poisoning was homicidal, in which arsenic had been directly administered, that Brouardel describes œdema occurring, and heart failure, and so on, and the dropsy coming on also.

8327. You mentioned that besides this heart condition, neuritis, herpes, and pigmentation have very much diminished, and even the pigmentation attributed to vermin?—Yes.

pigmentation.

8328. What significance do you attach to that? Do you regard it as meaning that the arsenic caused a tendency to that form of pigmentation, or that what was truly arsenical poisoning was mistaken for the other?—I think that a great deal of what we called the pigmentation due to vermin was arsenical.

8329. But do you think that, given chronic arsenical condition, the tendency to pigmentation from vermin would be increased?—I certainly think so, because you get a double irritation of the skin layers.

herpes.

8330. In the case of herpes, do you think the general distribution of arsenic among the beer drinking public increases the tendency to herpes?—I think it frequently caused a great deal of the herpes.

8331. But some herpes still remains?—Certainly. I should not like to say all herpes is arsenical.

8332. I only want to be clear whether you meant that arsenic as a predisposing cause to herpes has now been removed?—Certainly it has been removed. The number of cases is now quite few. You occasionally meet one in the ordinary way in hospital practice, whereas before one saw quite an epidemic of them.

8333. The pigmentation has diminished greatly. Will you kindly tell us in what light you are now inclined to regard the pigmentation in terms of arsenic, and of alcohol? Would you expect to find pigmentation from arsenic alone?—Certainly. I do not think alcohol will cause pigmentation.

8334. I meant in combination with arsenic. You would expect to find pigmentation from arsenic alone?—Yes, I have seen that. It is well known that arsenic, given as a drug, may cause most marked pigmentation.

8335. Of the same kind that you have described?—Exactly the same type. I do not think alcohol had anything at all to do with the pigmentation.

8336. You do not think alcohol adds to the tendency?—Not the slightest.

8337. (*Chairman.*) Alcohol drinkers who have no arsenic whatever would not show pigmentation in any case?—No, I do not think so.

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8338. (*Dr. Whitelegge.*) Would you say the same thing of neuritis—that the alcohol does not add to the tendency?—There I am rather inclined to think that the alcohol may, because, as I have said with regard to these two cases, I cannot now get away from the idea that alcohol will cause neuritis, but I certainly think it is extremely rare if it does, and, of course, it has never been of the marked type of the arsenical neuritis. I have never seen such marked types except from arsenic.

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8339. (*Sir William Church.*) Then you would think that your numbers, so far as they go—you must remember it is only a few months—would now show that alcoholic neuritis is less common in Manchester and its district than it was hitherto supposed to be in other large towns; I mean, that was one of the points that struck me so much, the large number of cases of peripheral neuritis that you used to have in Manchester as compared with what we were acquainted with in London?—Yes. Now I can give you some numbers which will show that. When I was at the infirmary as Resident Medical Officer, from 1887 to 1891, there were 20 cases of alcoholic paralysis, so-called, a year, in 118 beds or 120 beds. Now I have 800 beds of my own at Crumpsall, and I have a very large out-patients' department. I do not know how many cases are received there, but it is a very large department, and amongst all those hospital patients I have not seen a case of neuritis in the last nine months, except such as one could trace to the previous epidemic of arsenic—people who had had arsenical neuritis, and who either came back and said their pains were a little worse again, or something of the sort. I have seen only two cases in private.

Dr. E. S. Reynolds. 7 Mar. 1902.

8340. (*Chairman.*) In respect of alcoholic neuritis, Dr. Kelynack told us in the Manchester Royal Infirmary from 1892 to 1899 they had from twelve to twenty-one in-patients each year. That, I think, agrees with what you have been telling us?—Those are a different series of years, and you see the same proportion holds.

8341. Would you say there is none now?—We have not seen a case, I think, for the last nine months in the Manchester Royal Infirmary.

8342. That illness of which there were twelve to twenty-one in-patients each year between 1892 and 1899—there is no more of that now?—No cases at all. We have not seen one in the Manchester Infirmary for about the last nine months.

8343. Would it be right to infer that those cases which prevailed so much from 1892 to 1899 were really due to arsenic?—Inductively one would say yes. You have certainly removed, as I shall be able to show, a factor—namely, beer containing noteworthy amounts of arsenic, and the results which previously were attributed to beer as beer or as alcohol, have gone. By induction one would be inclined to say that previously arsenic had been the factor which occasioned these results.

8344. And there is no other difference in the *régime* between 1892 and 1899 and the present *régime* than that which has resulted from the inquiry into arsenic, and the means taken to prevent arsenic from getting into beer?—I do not think so, my Lord. I am sure the people are still drinking; they have not stopped drinking, that is quite clear. The Revenue Returns, I think, would show that.

8345. (*Sir William Church.*) I might ask you one or two questions. We have the returns from some other large hospitals besides Manchester. For instance, at St. Bartholomew's we find that out of a total of medical in-patients per annum—6,400—there were in five years forty-two cases of peripheral neuritis. Take the medical cases alone—there was an annual average of 2,441. That would be over 11,000 medical patients, among whom we get forty-two cases of peripheral neuritis?—That is an average of about eight a year in over 2,000 patients. In Manchester we got twenty a year in an average of 1,300 patients.

8346. Quite so, but I wanted to compare the condition of Manchester now with the condition of some of the other large towns in former years, so as to see what it is like now. We imagine Manchester is free from arsenical poisoning, and I wanted to see whether the numbers we now get approximate to the cases which were in other large centres of the population, and if that was the case we might conclude that they had been arsenic-free in former years?—I see the point, and I should imagine yes, or that perhaps Manchester may now be below other towns. Of course, I have not seen absolutely every case that has occurred in these two hospitals during the last nine months, and it is quite possible there may have been two or three from pure alcohol, just as I have seen two cases in private undoubtedly from pure alcohol—undoubtedly from spirit drinking.

8347. Considerable weight was laid by those who thought that all the neuritis in Manchester might be due to arsenic upon the fact that so-called alcoholic neuritis was very rare in Scotland?—Yes.

8348. But I and that in Scotland, in the Glasgow Royal Infirmary, out of a total number of 2,420 medical cases in five years, that would be the average number of medical cases a year?—That is the average.

8349. That the total number in five years was fifty-three, which you see is higher in Glasgow than it is in St. Bartholomew's in London?—Yes, but I should like to point out a fallacy there. It is generally supposed that in Edinburgh and in Glasgow the working man drinks spirits, and even Scotch physicians have told me so. But it is not the case at all. If you ask the employers of labour about it, who know the habits

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of these men intimately, you will find they undoubtedly drink beer, and they especially drink beer in Glasgow. They do not always drink spirits, by any means.

8350. That is not my point. My point is that your figures are now approximating, and I want to see how nearly they approximate, to what has been the figures of this disease in the other big centres. We know that your population were poisoned by arsenic; we do not know at present whether the populations in the other big centres were in any way affected by arsenic or not?—I see; but of course it has been shown——

8351. I think the evidence given to us from Manchester would hardly have led us to imagine there were as many as fifty-three cases of peripheral neuritis in the Glasgow Royal Infirmary in nine years, when we were told it was so excessively rare?—Yes, and so was I told that too. Sir William Gairdner was very strong on that point.

8352. In the Western Glasgow Infirmary, out of an average of 1,440 medical cases a year, we find that in five years there were nineteen cases of peripheral neuritis, and at Dundee, curiously, the figures are about the same—we are informed that there were nearly the same number of medical patients, 1,423 per year, and that the total in five years was eighteen?—That only amounts to three a year, with a larger number of patients than they have at the Manchester Royal Infirmary, whereas with us it was twenty.

8353. Now you think you may have had two in the months between November and July?—It is quite a possibility that there may have been two or three.

8354. That is rather approximating to those numbers that we got in our other returns?—That is so. I should say, taking it broadly, that Manchester now is in the condition of Glasgow and Dundee as regards neuritis.

8355. The highest figures, of course, are those which we got from the London Hospital in the East-End of London, and there, with an average of 4,600 medical in-patients a year, they get as many as 129 cases of peripheral neuritis in five years?—That is about twenty-five a year, with more than three times the number of beds than the infirmary. Of course, there they are largely gin drinkers in the East-End of London, are they not?

8356. I think that some of them drink many things. We have actual returns of only one year—out of sixteen cases during part of 1901 four drank beer only, three spirits, and eight both. You would be prepared to say now that the number of new peripheral neuritis cases in Manchester has dropped down to the level, or even below the level, of the cases in the other large centres of population?—I should say certainly below the level. It is extraordinary how free it is. You do not see them; they have gone.

Arsenical poisoning before 1899, largely due to malt.

8357. (*Dr. Whitelegge.*) Then you would not attribute the whole of that drop in Manchester to the use of a particular glucose—because, if I remember rightly, that did not begin until about 1899, and the pre-eminence of Manchester in the matter of neuritis existed before then?—No. Apart from the big epidemic in 1900 I think it was not necessarily the glucose, but very largely the malt also.

8358. You think there has been an improvement in the malt as well?—An enormous improvement. The South Yorkshire coke they will not have now for malting.

8359. Cases of neuritis attributed to alcohol, without mentioning arsenic, are still going on in small numbers, and especially in London, as Sir William Church said. Would you suspect some of those to have relation to arsenic still?—I should see that every case was most carefully gone into before I would be prepared to exclude arsenic, even in London.

Care necessary to exclude arsenic in "alcoholic neuritis" cases.

8360. Is there any practical suggestion you could make by way of a crucial test in determining whether a case of neuritis put down to alcohol had any arsenical origin?—There is one thing which sounds almost an impertinence, I was going to say. The investigation of the patient must be extremely searching. I say that because I have seen extremely good men examining these cases and entirely miss some of the symptoms—absolutely miss them; look at them and not notice them, and then confess they were there when they were pointed out to them. It seems rather an impertinence to say so, but I have seen so many extremely well-known men miss the symptoms of keratosis and pigmentation that the examination of the patient must be extremely searching. Another point is that the hair should in all cases be examined. If it contains a mere trace I should not think much of it; if it contains a considerable trace, or a considerable quantity, then I certainly think the history of the patient should be gone into, that all the foods and drinks, or some of them, at any rate, should be examined before you can exclude arsenic, especially the drink.

Significance of arsenic in hair

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8361. (*Chairman.*) Would not the examination of the hair be a very elaborate chemical process?—I believe now that it is fairly simple. I do not quite know what it is. I am not a chemist, I am sorry to say; but Dr. Dixon Mann has got now a fairly simple method, and Mr. Scudder also, and it does not take so long as it did, and it is much more reliable than it was; but it requires great care.

8362. If there is no arsenic found in the hair, you would take that as evidence, *pro tanto*, against the fact that the disease was due to arsenic?—Not necessarily. I think it would be in favour of it not being from arsenic; but, again, I have asked Professor Dixon Mann whether he would take it, if there was no arsenic in the hair, that the case was absolutely not arsenical, and he said, "No, you cannot go that far." The other day he had a case at the Salford Hospital, in which he felt pretty clear that there was some arsenical symptoms, and there was no arsenic in the hair. So that he says you cannot take it as an absolute rule.

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8363. (*Dr. Whitelegge.*) What importance do you attach to the discovery of arsenic in the urine? It has been suggested that there are cases in which arsenic is found in the urine of persons who are not supposed to be taking arsenic?—I should want very strong proof of that.

8364. Is it not within your experience or knowledge that arsenic is found in the urine of people who are not taking arsenic in one form or another?—No. To show how difficult these cases are from an analytical point of view, Professor Dixon Mann tells me that if he has used for these investigations a flask in which there has been arsenic in the flask in his experiments, he has then cleaned that flask and examined it in a good light, and there has not been a single speck or stain inside the flask; it has been apparently absolutely clean. He has taken that flask again, and in not a few cases without putting anything further into it obtained his arsenical mirror. He says you cannot depend on a flask which has once contained arsenic in making the next experiment. The result is that he never uses a flask a second time in which arsenic has been present. He says you cannot rely upon it being absolutely arsenic-free, if arsenic has been once in it. That shows how many results, such as these examinations for urine you are mentioning, may be fallacies. He keeps one set of flasks which are absolutely arsenic-free, and if there has been any arsenic in the flask he never uses it again.

8365. You have not only examined the hair for arsenic, but you have examined the urine?—Yes.

8366. And if you found arsenic in one or the other you would consider there was ground for assuming arsenical causation?—Most certainly, if it was in the urine.

8367. Just one other question. You told us of one 100th of a grain of arsenic being found in the beer consumed by certain patients?—Yes.

8368. When was that?—That was in September.

8369. Beer containing that proportion of arsenic was consumed recently and associated with recent cases?—I have here some tubes Mr. Scudder did for me yesterday for the Commission and asked me to bring down, in which he has collected a considerable number of Manchester beers, and two-thirds of them are arsenic-free. He can get no reaction whatever.

8370. At what date was that?—This week—since Monday.

8371. Recent samples?—Yes. The one-third of them contain traces, and the worst contain not more than 100th of a grain per gallon of beer. That is this week. Those tubes I have here. (*Tubes exhibited.*)

8372. (*Sir William Church.*) Those are presumably beers which have been recently brewed?—I should imagine so.

1/10 grain arsenic p gallon of would pr bably do harm.

8373. (*Chairman.*) Going back to the question of the presence of arsenic in beer for years past, what would be considered safe in respect to the quantity contained in beer? Given a susceptible person taking a moderate quantity of beer, say two or three pints a day, containing say one-fiftieth of a grain per gallon, might harm result, and on what grounds would you say that harm may result or harm could not result?—I should say, taking it at

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four pints, if I may, that is half a gallon, if it contained one-fiftieth of a grain per gallon I do not think any harm could result. That would only mean taking one-hundredth of a grain of arsenic per day—one minim of liquor arsenicalis, a very small medicinal dose. But, given a susceptible person, I should not like to see this dose much exceeded, especially as there is no need for it to be there.

8374. But you do not think harm could result from two or three pints of such beer per day?—I do not think so.

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8375. Do you know anything about the alleged tolerance of the Styrian peasants to arsenic?—Only what I have read, that certain of them can do so.

8376. It is said that after a little time they can take large quantities of arsenic without being poisoned?—Not in my own ordinary experience in hospitals; if you go on increasing it you are certain to get poisoning—in England, at any rate; I do not know about Styria.

8377. Can you give instances of what we are all told so often about Styrian peasants. Do you think it is true or not true?—I should not like to say. They have only to produce one of the Styrian peasants to negative anything I might say about it. It is quite possible some of them may be able to take large quantities of arsenic. I am informed by a late manager of the tin mining works in Singapore that the coolies who smelt the tin work all day long in an atmosphere containing considerable quantities of arsenic do not suffer, and they are men, moreover, who have not been affected with beri-beri. They are the men who have been gradually selected in the course of years from the coolies who have been able to stand the mining. They are big men and specially fed, because it is supposed to be a dangerous occupation more or less, and these men do not get any symptoms, although they are working in an atmosphere containing large quantities of arsenic. It looks there again as if certain men could stand it. That is the only evidence I can bring, apart from the Styrian statements, to show there may be something in it.

8378. Those men must inhale considerable quantities of arsenic?—Yes. My information I had direct from the manager of these works.

8379. Are they sometimes attacked with beri-beri?—He says very rarely, the smelters. But again he says that these are picked men who have been able to stand the mining.

8380. What class is it that is affected by beri-beri?—The ordinary mining coolie is very much affected, but of course they are imported fresh every year, thousands of them.

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8381. Is it now considered probable that the beri-beri is arsenical poisoning?—If I may go into that point, with a little more detail I would say that some time during the epidemic, speaking with Major Ross, and knowing that beri-beri was so like the so-called alcoholic neuritis, I thought it was possible and worth investigation whether the beri-beri—which, of course, is a terrible disease in the tropics—was possibly associated with arsenic. Major Ross, about September last year, brought over from West Africa an American lady, a missionary's wife, suffering from beri-beri, and asked me to see her with him in Liverpool. I went to see her. She was certainly not an alcoholic; she was a total abstainer, and yet she had all the symptoms of neuritis well marked, and also slight pigmentation, very marked pains in the legs, and the ordinary typical appearance of an arsenical case. She had had some rash also. She was a fair-haired woman, and therefore we thought it was possible there would not be any pigmentation. Her hair was examined by Professor Dixon Mann, and was found to contain, as he says, not mere traces, but considerable quantities of arsenic. Where she got it from we could not tell. She had lived almost entirely on tinned Californian fruits. Those fruits, I may say, have been again examined by Mr. Scudder, who asked me to bring the tubes here, and they have been found practically free. He has examined pears, apricots, and a whole lot of Californian fruits, and they are practically free. The most he found was 100th of a grain in a gallon of syrup, and, of course, nobody would take that. I think the Californian fruits, so far as his examination goes, can be set aside. Those tubes I have here also. It was at first thought that this idea of it being arsenical was very far-fetched, but quite recently evidence has been forthcoming to show that it is not quite so far-fetched. In the Indian Medical Gazette for September, 1901, Major Anderson reports two outbreaks of beri-beri on board ship, in which mouldy rice, heat moisture, insanitary conditions, scurvy, and alcoholism could be excluded, but the epidemics were by him clearly traceable to supplies of food obtained from Bombay in each case of the epidemic. Of course, he did not know at that time anything about arsenic. Then in the Perak Medical Report for 1900, Dr. Fox, the Acting State Surgeon, mentions that attention is being paid to the fact that arsenic may be the cause of the neuritis in beri-beri, and he quotes Dr. Conolly, the district surgeon at Batughia, who, in his annual report, says that up to the present a chemical analysis, of a not profound character, it is true, has failed to find arsenic in the urine of beri-beri patients. He goes on: "and in support of the arsenic theory I would point out that 95 per cent. of beri-beri cases treated are Chinese; and quite 90 per cent. are miners by occupation. When we know that arsenic in combination with other metals is common in the soil, where these Chinese have to stand for hours while searching for tin, we may regard the possibility of arsenic as a cause for beri-beri as being something more than problematic." Since then Professor Dixon Mann, if I may give this evidence, has, I know, examined the hair of 24 cases of beri-beri patients who have been sent to him from various parts of the world. Eighteen of those were blank; there was nothing in them. Six of them contained arsenic; I do not know in what amounts. Then Dr. Hughes, of Her Majesty's ship "Hamadryad," the hospital ship at Cardiff, recently sent me the hair of beri-beri patients who had come from Rangoon. This hair I again asked Dr. Dixon Mann to examine, and he very kindly did so. Two of them yielded no arsenic; one of them yielded an appreciable amount of arsenic, and one of them, the fourth, yielded more than a trace of arsenic. So that although I do not think that the arsenical origin of beri-beri is proved, still I think it is a subject that is well worth investigating, in the tropics more thoroughly, because it is such a fearful disease there. It is so very prevalent, and so extremely fatal. Then there is another point in the tropics also. The Hon. W. C. Brown, M.D., has informed me by private letter that in Acheen, an island somewhere opposite Singapore, they spread arsenic on the rice fields to kill the rats. That is a well known thing there. To keep the rats off the crops they put arsenic on the field. He has lived there, and he says it is well known. So that, at any rate, I think it is well worth investigating by tropical observers.

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Arsenic in hair of beri-beri cases.

Use of arsenic on rice fields.

8382. (*Chairman.*) Beri-beri has been sometimes, I believe, traced to the use of rice that was supposed to have suffered from fermentation or other injurious process?—Yes.

8383. Would that be rice dosed with arsenic in the way you now describe?—I should think it is quite possible it is in the grain, if they put it on the fields. I should think it is very likely in the grain. It has been clearly shown in some epidemics to be due to rice. In the Japanese Navy, I think, by altering the diet they got rid of beri-beri altogether. It used to be extremely prevalent in the Japanese Navy, and by re-arranging the diet they got rid of the beri-beri entirely. So that in that case it was food in some way or another.

8384. Do you know what the alteration was?—They lessened the rice, and I think they gave more nitrogenous food, as far as I remember.

8385. Is that custom of putting arsenic on the rice fields largely prevalent, or only in some exceptional cases?—That is the only evidence I have, and I could not say.

8386. The suggestion, which seems worth further inquiry, is that if giving up rice in the Japanese Navy was one of the means adopted successfully to do away with beri-beri, the rice might have been poisoned?—That is merely a suggestion for the basis of future work. I think it is being investigated by a good many tropical observers now.

8387. Going back to the case reported by Major Ronald Ross regarding the American missionary lady who was a total abstainer, we are told that arsenic was found in the hair—"it contained not a mere trace, but a considerable quantity of arsenic." Might it have been that it got in by an arsenical hair wash?—No. We inquired about that, of course, very carefully. She had not had any hair wash, and she had not as far as she knew—and she was an extremely intelligent woman—she had never taken any arsenic as a drug. Of course, she could not be absolutely certain. She knew what she had taken up to a certain extent. She said she has been taking quinine and some other drug, but that she had not taken any arsenic.

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8388. Had she been taking rice—living much on rice on the West Coast of Africa?—She said she had lived principally on tinned fruits, and tinned foods generally.

8389. Can you say anything of the quantity of the hair of that lady which was examined?—I am afraid I cannot give the exact weight, but I cut it off myself. It was about eighteen inches long and about the thickness of a pencil. I took a long piece so that it could be examined from end to end.

8390. Details of the chemical examination would be very useful to the Commission?—Dr. Dixon Mann's letter was "From ·3 grammes of the hair—that is five grains, of course—I got as much arsenious oxide as I did from the same weight in the general run of cases at the time of the outbreak of epidemic arsenical poisoning." From 5 grains of the hair he got as much arsenic as he did from the same weight of hair in the cases during the arsenical outbreak—the beer cases.

8391. Five grains of hair, that is ·3 of a gram.?—Yes. He says, "You may accept it that the arsenic I found proved that a considerable quantity had been taken into the system of the patient either by administration as medicine or in some other way." Of course, he did not know how it had been obtained any more than we did.

8392. You have told us that the lady had not taken any arsenic medicinally?—She had not, as far as she knew.

8393. From the large quantity it seems that somehow accidentally she must have taken arsenic?—Yes, certainly. And, of course, one may mention that beri-beri did occur in the same district. She came from somewhere up-country—I forget just now where—on the West Coast, and it was known there. Major Ross saw her there and brought her over himself, and he told me that nobody there doubted for a single second that she had beri-beri. It was diagnosed as being a typical case of beri-beri, and he was asked to bring her home because she was supposed to be dying.

8394. Did the lady recover?—Yes; she got all right as in the arsenical cases.

8395. Was she damaged in her health?—No. She was doing extremely well the last time I saw her, beginning to move her limbs and going on all right.

8396. But she was so ill when she left West Africa that she was considered to be like a dying person?—Yes. She was not supposed to be going to get home alive or live more than a few days, but it was the only chance to remove her outside of the district. That is the usual treatment for beri-beri, to remove the patient out of the district.

8397. There was no doubt it was something in the food or air of the district?—It certainly looked like it in that case.

8398. (*Sir William Church.*) You mentioned the coolies who worked at the tin smelting. Have you made any inquiries yourself as to the workers in arsenic in this country?—No, none at all.

8399. We shall perhaps have other evidence on that. You have not made any inquiries about beri-beri in Java, have you?—No, I have not had any opportunity at all. This, of course, is a question which ought to be investigated on the spot.

8400. I mean it is stated, and I think proof has been brought forward, that Europeans in Java suffer largely. There are a large number of cases of beri-beri among the Dutch troops?—I believe that is so.

8401. But you have no information?—No, I have no information at all.

"Alcoholic neuritis" before 1899 attributable to arsenic.

8402. (*Chairman.*) Would you go back to the question of the presence of arsenic in beer for years? Will you kindly give your own statement from your *précis*?—From my clinical observations during the last seven or nine months I am driven to the conclusion that the disappearance during this time of so many symptoms which were formerly described as due to alcohol can only be explained by the elimination of arsenic from alcoholic beverages, and as a corollary that arsenic has been present in alcoholic beverages to an extent dangerous (at any rate to a few drinkers, especially susceptible) for many years, and possibly from a source entirely independent of contaminated glucose.

Halifax outbreak, 1902.

8403. Can you also tell us about cases which we understand have recently occurred at Halifax?—The Halifax cases I visited on January 21st at the request of Dr. Hodgson. They were in St. Luke's Hospital, Halifax. I saw there five cases, four men and one woman. I do not know whether you wish for the names. One man,

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named Lee, had very marked pigmentation, a hoarse voice, marked loss of power, and pains, but he had no keratosis. This man was the colour of chocolate.

Symptoms.

8404. All over?—Yes, all over.

8405. Over the face and body?—Not so much the face; that was darkish, but not so marked as on the body.

8406. How long might it have taken for that colour to be developed over the whole body?—I should put it possibly at two or three months.

8407. Had he that colour when he came in the hospital?—I believe so, yes. A man named Whalan had marked loss of power, marked pains, some keratosis, and no pigmentation. In a man named Marsden I did not notice many symptoms. I believe, as a matter of fact, some arsenic had been found in his urine; but clinically, apart from the chemical question, there were not many symptoms. A man named Shearing had very marked keratosis and loss of power, and marked pain, and a hoarse voice. A woman named Lowrie had pigmentation and pains, and keratosis, and loss of power. So that four of these cases, three men and one woman, were clinically most undoubted cases of arsenical poisoning of a fairly marked type. Some of them were of a very marked type; there was no doubt about them whatever. You could tell when you went into the ward. In two cases I went straight up to the patients; they were strange wards to me, but from the look of the patients I went straight up to them. There was no doubt of them at all; they were marked arsenical poisoning cases. Where the arsenic had come from I do not know. But clinically there was no doubt they were arsenical poisoning cases.

8408. Was there peripheral neuritis in each of those cases?—In each case except Marsden, in which I say the symptoms were very few so far as I made out. In each of the others there was some neuritis, loss of power, and pains.

8409. In an original fatal case mentioned, Dr. Hodgson chemically proved the presence of arsenic in the body?—That I do not know anything about. I did not see the case to which you refer, the one the first inquest was held upon. The man—McNulty, I believe his name was—was dead when I was there, and I do not know anything about him.

8410. Had the urine been examined?—That I cannot say; I do not know.

8411. Is it usual to examine the urine of patients admitted to hospital and suspected of being arsenical?—Yes, one would examine certainly in a recent case suspected to be suffering from poisoning by arsenic.

8412. (*Dr. Whitelegge.*) Then four, at least, of these cases were well-marked arsenical poisoning?—I do not think there is the slightest doubt about it.

8413. They were diagnosed by Dr. Hodgson before you saw them?—Yes.

8414. Dr. Hodgson had seen cases at Crumpsall?—Yes. He had seen them at the Manchester Infirmary—my out-patient department.

8415. But he had seen them with you at Manchester?—Yes. He was one of the students there.

8416. Were they recognised by the other medical men in Halifax?—That I cannot say. I do not know at all.

8417. I have a report here of the inquest, and the question arose how far the death in the case of Lee—it was the second inquest, was it not?—Yes. That was the man I saw.

8418. The question being put: What, in your opinion, was the cause of death? the reply from Dr. Woodyatt was, "I should say that he died from acute croupous pneumonia. There is no doubt he had arsenic in the system, but I cannot express an opinion whether it contributed to his death or not. Before the post-mortem I was of opinion that he died from arsenical poisoning; after the post-mortem my opinion was very much modified." You saw Lee some days before his death?—I saw him on the 21st January; I do not know when he died.

8419. The inquest was on February 7th?—He would die within ten days, at any rate.

8420. At that time did you regard his as a grave case of arsenical poisoning?—Yes, I thought Lee was going to die as soon as I saw him.

8421. From arsenical poisoning?—Well, from his general condition, which was arsenical poisoning. The

fact that he died from pneumonia certainly does not exclude arsenic in a peripheral neuritis case; that is what they often die of.

8422. You say arsenical poisoning is arsenical poisoning even if it occurs in a diseased person?—Certainly; these neuritis cases not infrequently, and paralysis cases generally, not infrequently die of pneumonia. Pneumonia is a mere termination of the illness, but because they die of a termination you cannot say the primal cause is not the cause. That is the cause which puts them on their backs, and puts them in a weak condition.

8423. You gave us particulars of cases in which at the time of death phthisis had been given as the cause?—Yes.

8424. You regard those in the same light?—Certainly. I cannot help thinking that, contrary to what is being done just now in giving arsenic to phthisical cases, arsenic puts a person in such a condition that they get very rapid phthisis. One cannot get away from the idea; the phthisis in these cases is so extremely rapid and so prevalent—10 out of 13 men. The proportion is too great to neglect.

8425. (*Sir William Church.*) Just to clear up one point. I rather gather from what you said before that these cases were rather what we should term cases of general tuberculosis than phthisis. You said that the ascites was due to tubercular infection of the peritoneum?—That is so.

8426. Later leading to more rapid disintegration of the lungs?—That is so. It is quite possible that some of them may have been old tubercular subjects. That I do not know; but as soon as they have apparently got this arsenical poisoning the consumption runs riot in the most extraordinary way.

8427. Did any of them die with tubercular meningitis?—No, I do not think so. I do not remember a case of that.

8428. But especially with general disseminated tubercle through the abdominal organs?—Yes.

8429. Were there any masses of tubercle in the organs as well as on the peritoneum?—No. It was more on the surface of the peritoneum. The greatest mass of the tubercle was in the lung.

8430. Do you think that in all cases it was in the condition of breaking down in the lung?—Yes; it was mostly a rapid breaking down.

8431. Not quiescent?—Not quiescent.

8432. (*Dr. Whitelegge.*) Can you suggest why an outbreak should have occurred in Halifax and not elsewhere? Are you aware of any other local outbreak since the epidemic in Manchester and elsewhere?—No, none.

8433. Can you suggest any reason why it occurred in Halifax?—I should think their beer ought to be examined. I do not know whether it has been, and I should think the malt ought to be examined too; that is all I can suggest.

8434. You do not think an outbreak of that sort could occur and escape observation?—It might do by careless observers; but I do not see how you could possibly miss those cases at Halifax, especially when several came under the notice of a single observer in a short time; they were so marked.

8435. Dr. Hodgson identified all, did he not?—He identified every one.

8436. And as far as you know other medical men in Halifax were equally on the alert?—It is quite possible. I know a good many of them, but I do not think any had seen the Manchester cases except Dr. Hodgson.

8437. Very many medical men, not only in Manchester, but in neighbouring counties, have been to see the cases at Crumpsall—to see your cases?—Yes; a good many have seen them.

8438. So that knowledge of the symptoms is now pretty widely diffused?—I think so now. I think if a distinct outbreak such as the Halifax outbreak occurs in any other town it will be certainly found out.

8439. Would you say as much of an outbreak of that kind occurring before the Manchester epidemic to which you drew attention?—No.

8440. Assuming for a moment that it had happened five years ago?—I feel pretty certain it would not have been found, and my reason for saying that certainly is this: That able physicians in Manchester, until I happened to find out what the cause of it was, let all these cases go for six months. I did myself. We put it down to beer and so on.

8441. So that this, which in your own opinion was an epidemic of arsenical poisoning through beer, would have escaped notice altogether?—I have no knowledge that it was through beer in Halifax.

8442. But it would have escaped notice before this outbreak of arsenical poisoning had called attention to the matter?—I do not think there is any doubt about that. I think it would have certainly escaped notice.

1/10 grain of arsenic daily, considered harmless.

8443. Just two questions here on details. You said in reply to Lord Kelvin that you thought small quantities, such as 1-100th grain daily, could not in practice cause mischief?—No more than 1-100th grain—I do not think it would.

8444. In what light do you regard the cases to which reference is made on the top of the second page of your proof. You mention that with "two exceptions they were women who said they had only recently (about May) become affected; in each of these cases Professor Dixon Mann found a fair quantity of arsenic in the hair, and Mr. Scudder, in my presence, examined some beer and stout (which one of the women had consumed), and minute traces (about 1-100th grain As_2O_3 per gallon) were found." Do you think of that quantity of arsenic as having done no harm, and as not being related to the disease?—In that particular woman at that time?

8445. Yes?—I do not think so. I think it was an old case.

8446. They had consumed beer containing a greater proportion of arsenic than that?—Yes, and previous to that. I do not think it was that one-hundredth that did it. I only mentioned it to show that it was arsenic in that beer she was drinking. I obtained it. Mr. Scudder examined it.

8447. And even in a susceptible person you would say one hundredth of a grain consumed daily is practically harmless?—I should think so. I have given large quantities of arsenic in all sorts of doses, and I have never seen one minim of liquor arsenicalis produce any symptom.

Significance of arsenic in hair.

8448. I want to be clear as to what inference you draw from the absence of arsenic in the hair of a suspected case of arsenical poisoning. Do you mean that the real absence of arsenic is not a disproof of arsenical causation of mischief, or do you mean that the analysis requires great skill, and, therefore, a reported absence does not prove much unless you can depend on the skill of the analyst?—No. Taking the skill of the analyst as the highest and supposing arsenic was found absent, it certainly would be a point against the case being arsenical poisoning. But I do not think it would be an absolute proof, from what Professor Dixon Mann has told me.

8449. So that although arsenic has an affinity for these tissues, it is not to be assumed it always finds its way into the hair?—According to what Dr. Dixon Mann tells me, and he has made most careful investigations over a very large number of cases.

and in urine.

8450. (*The Chairman.*) In a well-known text-book "Principles and Practice of Medicine," by Ostler, 1901, we have a remarkable statement:—"J. J. Putnam, an American Chemist or Physiologist, has shown that it is not uncommon to find traces of arsenic in the urine of many persons—thirty per cent.—in apparent health." If in thirty per cent. of people in perfect health apparently arsenic is found in the urine, how are we to explain where that came from, and what must we reckon from arsenical testing of the urine in cases of poisoning?—I should want that confirmed.

8451. You do not feel quite confident in the statement I have read?—I should want several observers to find exactly the same before I believed it. It may be true.

8452. (*Dr. Whitelegge.*) Would not you go further than that and say if the arsenic has been excreted it must have been acquired in some way?—Yes.

8453. So that all that that would amount to would be that there was arsenic which was being excreted, and had not given rise to symptoms which were noted?—Yes. It must be coming from somewhere. Supposing it is always present in the urine from those patients, it has got to come from somewhere; if there is an output there must be an input somewhere; it cannot be coming from nothing.

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8454. (*Sir William Church.*) You have already drawn our attention to the apparent fallacy that unless the examiner of the urine is aware of the difficulty of cleansing the flask or of the possible contamination from the glass of the flask a fallacy is introduced?—Exactly. What might happen quite easily would be; he has say two sets of apparatus, if you like, and in one he gets arsenic from a person who has been taking arsenic. He goes on with a flask, and cleans it, and goes on examining the next person's urine, and again gets arsenic, and so he gets this 30 per cent. easily enough if he is not aware of that point. He may be; but extreme care ought to be taken in these cases. I think that statement requires very strong confirmation before one can act upon it at all. There are some of these tubes here, which, perhaps, the Commission may like to see. They have been given to me by Mr. Scudder for the purpose. That is a tube showing the arsenic from one grain of reduced iron in the market; it contains one per cent.

8455. (*Chairman.*) One grain of reduced iron?—What we use in medicine, *ferrum redactum*.

Arsenic in reduced iron, 1 per cent.

8456. That drug must have contained a great deal of arsenic?—A very great deal—one per cent. It has been found that reduced iron used in medicine contains about one per cent. of arsenic.

8457. Is that general, or is it only a particular specimen of iron which contains so much?—Every specimen that Mr. Scudder buys on the market. He has got it straight from the manufacturers, and each specimen, even those which are guaranteed to be made according to the formula of the "British Pharmacopœia," one stated to be made according to the "British Pharmacopœia," contains about one per cent. That is one of these tubes.

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8458. That is a somewhat alarming statement?—One only gives one grain or two grains of the iron.

8459. How much per cent. did you say?—One per cent.

8460. One per cent. of arsenic, if that medicine is prescribed, and used by patients a good many grains at a time?—One does not use very much of it. One does not use more than two or three to five grains at the outside.

8461. But it would introduce a considerable quantity of arsenic taken three times a day; the arsenic would soon run up?—Yes. And that is quite a possibility. I think it is just as well it should be known; it is so. Personally I only give very small doses of this iron.

8462. You would think it important for medical practitioners to take note there is one per cent. of arsenic in reduced iron?—Yes, I think so.

Mr. Arthur Angell, called; and Examined.

Mr. A. Angell.

8463. (*Chairman.*) You are Public Analyst for the County of Hants, and for the City of Winchester, and the Borough of Guildford?—Yes.

8464. And you made some investigations in association with Mr. Arthur French Angell?—Yes; he is my son, and assistant.

8465. What were the objects of the experiments?—It was to satisfy us upon an interesting point; to determine whether or not plants took up and assimilated arsenic from arsenicated manures.

Experiments as to absorption of arsenic by certain plants.

Using arsenicated manure;

8466. Your soil was manured with arsenicated phosphates. Is that the only suspected way in which arsenic can get into the manure?—It is the only way that indicates itself to my mind distinctly, because all the superphosphates contain arsenic; but these experiments were done with a specially arsenicated manure—arsenicated with a half per cent., which was seventeen times greater than any quantity I have ever found to be present in ordinary phosphates of commerce, so that the trial is a drastic one—an extremely drastic one.

8467. By arsenic you mean arsenious oxide, and the weight you speak of are weights not of the arsenium but calculated as arsenious oxide?—Quite so.

8468. In the phosphates is the arsenic supposed to be present in that combination, arsenious oxide? Is that known?—I should anticipate that the acid present would probably render it more soluble than the oxide would be in its free condition.

8469. You use an ordinary superphosphate of lime, and mix it with a half per cent. of the oxide?—Yes, which is now called arsenic.

its application.

8470. How was the application of the manure made?—Half the manure was applied at time of sowing and half when the young plants were well above ground; care being taken on each application to avoid actual contact between the manure and seed or plant.

8471. How was the solubilty of the arsenic in the manure tested?—That was an important point, which was determined by experiment. It was to show that the arsenic in the superphosphate was readily soluble in cold water, and therefore would be soluble in the moisture of the soil.

Method of testing the plants.

8472. What was the method of the estimation of arsenic you followed?—We have given that the name of Hehner's modification of Marsh's process, which I think must be the same as the tubes which the last witness produced. We have come to the conclusion it is the best process for the estimation or determination of minute traces of arsenic, and it yields very close approximations of the actual quantity present in dilutions of one part of arsenic in ten millions.

8473. You made reference mirrors?—We made a series of mirrors from known quantities of arsenic for comparison with the mirrors we obtained, and by that means one can make a very fair approximate estimation of the actual quantity the mirror represents.

Mr. A. Angell.

8474. Did you take precautions as to the purity of the acid?—There was difficulty found in obtaining arsenic-free acid. One would anticipate, and we had anticipated, that the boiling of hydrochloric acid would free it from arsenic, but some samples were found which did not free themselves even after very prolonged boiling.

8475. Did the same difficulties occur with zinc? Metallic zinc is very apt to contain arsenic, is it not?—That is so. We succeeded in getting a good quantity of zinc arsenic-free, even from the shadow of a trace.

8476. What apparatus did you use?—I sent up a sketch of the apparatus, which the Secretary informs me he sent back to me. I have a rough pencil sketch here, from which the drawing was made, although I am not sure it is large enough to be of any value. (*Drawing put in.*) That is simply a rough pencil sketch made in the laboratory at the time.

8477. (*Chairman.*) It is quite clear. Can you describe it with reference to this sketch?—A description, I take it, my Lord, would not be necessarily the size of every part, but simply general?

8478. Simply general?—The apparatus consisted of a flask furnished with a separating funnel, the size of the flask being 300 cc., and the funnel 100 cc. The usual cleansing and drying tube was used, a plug of cotton wool coming first, then lead paper, then calcium chloride, then lead paper again, and then cotton wool again. After that one of the small tubes with which Hehner first associated his name by bringing them before the notice of the Society of Chemical Industry. That is why I have used his name in conjunction with Marsh's.

8479. Is Hehner's tube an addition to or rather a modification of Marsh's method?—The method has not been altered in any way except that it has been brought down to a much more manageable form by Hehner. The first few of our experiments were made with the larger form of tube, and bigger apparatus altogether. When I saw the tubes at this meeting I spoke about, I at once saw the manageability of the thing was very much greater. I think the tubes shown here just now were made in the same manner that Hehner makes his tubes.

8480. What was the modus operandi?—I took 20 grammes of zinc, 50 cc. of hydrochloric, or an equivalent of sulphuric acid, and placed 100 cc. of water into the funnel and allowed sufficient to flow into the generating flask to cover the zinc and fill the stem of the funnel; added sufficient acid to set up the action, and after a short interval ignited at the capillary point. Even if not air free, the explosion will not go further back than the cotton wool plug in the drying tube. I heated the hard glass tube five minutes blank, and then added gradually the fluid to be tested. The experiment should last 15 minutes, and more if foaming takes place, as the foam retains the arseniuretted hydrogen. In some

instances the foaming in the generating flask became unmanageable; this can be avoided by first gently heating the plant or seeds in dilute acid for some hours in an open beaker and subsequently filtering.

8481. **Have you compared the mirror formed when you use sulphuric acid and when you use hydrochloric acid?**—I find no difference.

8482. **I think Dr. McGowan has found in experiments for us, and perhaps Mr. Hehner has also found, that a mirror when sulphuric acid is used is not comparable with that from hydrochloric acid?—Do you know the meaning of the word comparable in that instance?**

(*Dr. McGowan.*) We have so far always used the sulphuric acid mirror until quite recently, but the hydrochloric acid mirror seems to be of a different type, and I should say rather more marked than the sulphuric acid mirror. I have not had much experience yet of the hydrochloric acid, but it strikes me it is rather more marked, so far as my experience goes.

(*Witness.*) I have not noticed that.

(*Chairman.*) **You can get a good mirror with one or the other?**

(*Dr. McGowan.*) You can get a good comparable mirror with one or the other. I think the hydrochloric acid is rather the more delicate.

(*Witness.*) I think I would agree to that last remark that it is rather more delicate if anything.

(*Sir William Church.*) I gather that you mean hydrochloric acid mirrors ought to be compared with hydrochloric acid mirrors, and sulphuric acid mirrors compared with sulphuric acid mirrors, but that being done there is not much difference between the two.

(*Dr. McGowan.*) It is a matter of personal taste really.

(*Witness.*) I agree with that.

8483. (*Chairman.*) **In your determination of arsenic in superphosphates, was the aqueous acid solution of the superphosphate introduced directly into the apparatus?**—Yes.

8484. **Was there no interference with the test from any small quantities of organic matter in solution?**—No, not in the case of superphosphates, no interference.

8485. **Were precautions taken to prevent any arsenic getting accidentally on to the leaves of the growing plants? Was there any wind?**—The danger was the introduction of arsenic either carried by wind or the splashing of rain, or otherwise, on the surfaces of plant or leaves. That was a source of danger, and we kept it before us the whole time.

8486. **Did you use any precautions to prevent it, or wash off the arsenic?**—We washed all the plants and all the parts of plants carefully in every instance.

8487. **In your use of the Hehner-Marsh method what kind and size of drying tube for the escaping hydrogen was used?**—The drying tube was 14 inches in length and five-eighths in diameter. The mirror tube was five-sixteenths outside diameter, and about nine or ten inches long.

8488. **What length of chloride of calcium did you have in the drying tube?**—Rather more than half the entire length; that would be seven inches.

8489. **In fragments, small lumps?**—Yes, calcined and in fragments.

8490. **Does your use of the Hehner-Marsh method involve any treatment of the leaves, seeds, etc., before Marshing?—Usually it was better to cut up the pieces** of plant or crush the seeds, and gently heat them in an open beaker with a little acid with them. That was my usual plan. It did away with a good deal of the danger of foaming in the flask.

8491. **Did you use the whole liquid and solid together, or filter?**—In some instances it was necessary to filter, but if it was a thing you could pulp down sufficiently to get through, I preferred not filtering.

8492. **Why did you prefer not to filter?**—Because some of the arsenic would be probably left in that portion which was upon the filter.

8493. **If there was no previous treatment of the leaves and so on, were estimations made with the same samples after the destruction of the organic matter? If you did not treat previously, did you take any means to destroy the organic matter before Marshing?**—In most instances, it was not necessary. The result of maceration was sufficiently free from organic matter to permit the process to be carried out.

8494. **If the organic matter was destroyed, how was it done?**—I do not think it is necessary with these vegetable infusions to destroy the organic matter.

8495. **Did you never destroy the organic matter?**—Not entirely.

Organic matter was not entirely destroyed before Marshing.

8496. **What quantities of the samples did you employ?**—Taking the first instance, which was on the 21st April, we took rhubarb stems, that is the leaf stems of the rhubarbs used for feeding purposes. We took 50 grammes and boiled in dilute hydrochloric acid, and from that we obtained a slight trace of arsenic.

8497. **Did you take about 50 grammes in all these experiments in each case?**—In each case, right through.

8498. **Did you get any appreciable evolution of sulphuretted hydrogen along with the arseniuretted hydrogen?**—In one or two instances only, not as a rule, but where it occurred it was picked up by the lead paper.

Control and blank experiments, and their efficiency.

8499. **Assuming no previous treatment of the sample in a sufficient number of cases, when the sample yielded no arsenic, did you make a control experiment with another similar sample and a given small amount of arsenic?**—No. That is to say did I ever introduce arsenic to prove that if it had been there I should have found it?

8500. **Yes?**—No. I have done this in a certain way. It has happened that a negative result has been obtained from a quantity of a non-arsenicated plant or substance, and then afterwards my son, to corroborate what I have done before, with a portion of rhubarb stem in which we had found arsenic, has gone on with the experiment in which I found none by adding some of the arsenicated rhubarb, and then has got his mirror. That therefore is something of the same sort.

8501. **Did you ever recover the whole of the arsenic that was added in any one of your experiments in which a known quantity of arsenic was put in?**—That could be only in the case where I tested my manure. I could not expect in any way to get back again the arsenic I had put into the soils quantitatively.

8502. **Did the organic matter in the flask retain any portion of the arsenic so far as you know?**—Not so far as I know. I found it was extremely slow in coming off; extremely tardy. So that it was a question sometimes of hours before the last trace of arsenic came off if there was a thick foam forming on the surface of the boiling flask. I take it the bubbles contained arseniuretted hydrogen; and therefore as long as any of that foam was there there was danger of arsenic in the flask, so I continued until I had boiled it out.

8503. **There is a prevalent idea, I believe, that organic matter may seize hold of the arsenic and prevent it going away in the Marsh test?**—Retaining the whole of the arsenic present?

8504. **No, keeping a part of it?**—I think that is possible, but I have not had experience of that.

8505. **Did you ever allow the blank to run over the same length of time as was taken up for that actual estimation?**—Yes. I have allowed it to run to the point of absolute total exhaustion; that is to say, until the whole of the hydrogen has come away, simply for a blank experiment.

8506. **Did you ever obtain any false mirror—one that was carbonaceous?**—No. I know nothing of that. I have seen a slight discolouration which has led one to suspect a mirror was about to be formed, but I have never had a case where it was not sufficiently decisive if you actually got arsenic to be able to detect the fact.

8507. **Were the solutions and extractions reduced to the arsenious state before Marshing?**—No steps were taken before the liberation of the hydrogen to reduce it. The question, I think, means this: were any steps taken to reduce a possible arsenic compound to the arsenious state before its introduction into the flask?

8508. **Yes?**—The answer is no.

8509. **Has it been ascertained that the whole of a given quantity of arsenic acid would be reduced and deposited in fifteen minutes?**—Although fifteen minutes is the time that we give as being in most instances sufficient, we have never confined ourselves to a rigid line about time. As long as there was the slightest evidence of further deposit we would go on; and in some instances it was a very long time indeed.

8510. **It would be very interesting to understand what degree of confidence may be placed in results in which the answer is negative, "No arsenic mirror discovered"?**—I see the importance of the point.

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8511. We want to prove that there was no arsenic there?—I am firmly convinced from my own experience that if arsenic is present it must be due to carelessness of the operator if he does not find it.

8512. Dr. McGowan informs me that with smaller quantities of re-agents it sometimes takes from three-quarters of an hour upwards for the arsenical mirror to appear in estimations which have been made?—Were those organic mixtures of plant matters?

(*Dr. McGowan.*) Mixtures in which the organic matter was destroyed.

(*Witness.*) What class of organic matter was it? Animal matters? If so that hardly comes in as regards our cases.

(*Dr. McGowan.*) Principally animal matters, but I think one or two vegetable matters as well, though I could not say from memory.

(*Witness.*) We carried our experiments in every instance a long way past the fifteen minutes. If any indication came, it always came within the fifteen minutes; a slight indication, any possible change or deposit, was sufficient to make us go on with our experiments until we were perfectly sure we had exhausted them.

8513. (*Chairman.*) In other experiments, in the case of arsenious acid, it has been found the deposit completed in most cases in twenty minutes?—I agree with that.

Possible retention of arsenic by organic matter: should be investigated.

8514. It might in future experiments add greatly to the value if we had distinct evidence that the whole of the arsenic was taken out by a continuation of the process?—In the presence of organic matter?

8515. Yes?—I will undertake to do that.

8516. And whether the original form of the arsenic was arsenic acid or arsenious oxide?—We will undertake to experimentalise with the two forms of oxide, the arsenious and arsenic conditions, under the conditions you are indicating; that is to say, we will make a blank with our vegetable solutions or decoctions, or whatever you call them, and then we will add in one set of instances arsenious oxide.

8517. Add it to the vegetables, not the vegetable decoction—to the vegetables before decocting?—I do not see how that is to be done.

8518. Add it to the liquid before macerating?—Yes, I see. I could not add it to the vegetable matter. If I have the opportunity of sending up my notes I will undertake to carry those experiments out.

Soil contained arsenic after growth of experimental plants.

8519. (*Chairman.*) What about testing the ground?—I thought it was a point of interest to know that we had sufficiently arsenicated the soil to show that a plant had been submitted throughout its life history to the conditions under which, if it was capable, it would take up arsenic, and therefore we took samples of the earth after the experiments had been finished with the plant, and found that it still contained arsenic.

8520. As if the plant had taken some arsenic, but had not taken all the arsenic?—That was not the only object. The object we had in view was to show that the plant during the whole of its career had been under the influence, at all events, of an arsenicated environment.

8521. That the arsenic had not been washed out of the soil?—Yes, just so. That is what we wanted to show.

Nature of plants experimented with.

8522. What were the plants and seeds tested?—The plants and seeds experimented upon were wheat, barley, rye, oats, peas, buckwheat, maize, beans, cucumber, tomato, rhubarb, mangolds, carrots, lettuce, and cabbage.

8523. At what date were the seeds planted?—The rhubarb was in my own garden, and I do not know how long it had been planted, but it was arsenicated immediately as it was appearing above the ground; that was before the 21st April, about the time it springs from the ground.

8524. Which was arsenicated, the soil or the rhubarb?—The soil was arsenicated. It was arsenicated around the plant. The plant threw up three or four growths, and this was arsenicated in a little ditch round the plant and covered in with earth. That I did myself. The following is the list of the experiments:—

Results.

LIST OF EXPERIMENTS: 1901.

April 21:

No. 1—Rhubarb stem, taken 50grms.; boiled in dilute hydrochloric acid. Slight trace of arsenic.

No. 2—Rhubarb leaf blade. A slight trace of arsenic.

May 3:

No. 3—50 grms. peeled rhubarb petiole. A faint trace of arsenic.

No. 4—The peelings of leaf stalk. Very faint trace of arsenic, less than 1, 2, and 3.

May 11:

No. 5—Cabbage, 50 grms. of the heart. No arsenic.

No. 6—50 grms. of stump. No arsenic.

May 22:

No. 7—Barley. Whole plants pulled up by root. Faint trace of arsenic.

No. 8—Oats. Ditto. No arsenic.

No. 9—Buckwheat. Ditto. No arsenic.

June 19:

No. 10—Growing green stalks and bursting ears of barley, 50 grms. Not a trace of arsenic.

June 24:

No. 11—Maize, tops of plants only. No arsenic.

June 26:

No. 12—Buckwheat. Flowers and stems cut 6 inches from ground. No roots. Very faint trace of arsenic.

No. 13—Second sample ditto ditto. Rather more arsenic than in No. 12.

June 29:

No. 14—Ryegrass in green ear. Upper parts of stems and ears only. Faint trace of arsenic.

July 1:

No. 15—Broad beans. Pods and seed, young and green, nearly fit for table. Well-marked mirror of arsenic, estimated as one part in thirteen millions of the solution.

July 2:

No. 16—Broad beans. Foliage and stalks, no pods nor seeds. Arsenic same as in No. 15.

July 4:

No. 17—Green barley ears. No arsenic.

July 27:

No. 18—Barley ears nearly ripe. A fine specimen. No arsenic.

No 19—Buckwheat seeding heads. No arsenic.

July 31:

No. 20—Green peas; no pods. No arsenic.

August 5:

No. 21—Ripe barley. A fine sample. No arsenic.

No. 22—Ripe oats. No arsenic.

August 8:

No. 23—Lettuce. No arsenic.

August 10:

No. 24—Ripe barley. Second sample. No arsenic.

August 13:

No. 25—Carrots. No arsenic.

August 19:

No. 26—Male flower of maize. No arsenic.

August 22:

No. 27—Green maize, corn cob with sheath. No arsenic.

August 30:

No. 28—Tomatoes; fruit. No arsenic.

September 3:

No. 29—Broad beans. Ripe seed. No arsenic.

September 5:

No. 30.—Ripe wheat seed. No arsenic.

No. 31—Mangel. No trace of arsenic.

No. 32—Cucumber. No arsenic.

8525. (*Chairman.*) Is No. 31 the mangel wurzel?—Yes.

8526. (*Sir William Church.*) These dates that are given, are they the dates of the experiments or the date when the arsenicated manure was put on?—These were the dates of the experiments—laboratory dates.

8527. When did you apply the arsenicated manure to the growing rhubarb?. I understood you to say you applied the arsenicated manure on the 21st April?—I was wrong in that. That is when I made the estimation; it must have been previous to that—I should think at least a fortnight.

8528. Therefore these dates given are the dates of the laboratory experiments?—Yes.

8529. And I understand from what you have said before that in the case of all the seeds some was applied at the time of sowing and some subsequently?—Yes.

8530. Does that apply to the cabbage too?—Yes, but not to the rhubarb.

8531. It applies to all in fact, excepting the rhubarb?—Yes.

8532. (*Chairman.*) Some arsenic was put into the manure before the sowing of the seed, is that so?—The whole of the manure was arsenicated at one and the same time.

8533. Was the manure applied before the sowing of the seed in some cases?—No; at the time of sowing. The first manure was put adjacent to the seed at the time of sowing, not actually touching. I do not know that there was any reason why, but putting a large quantity of strongly arsenicated manure there might have been some action preventing the sprouting of the seed, so we avoided that, and put it in close proximity to the seed, and then covered the seed in the ordinary way. The seed was sown by a practical man in my presence, better than I could have done it myself. Subsequently, before the young corn had got more than a very green show of grass, another portion of manure was put around it at a further distance from the plant than before.

8534. In a circle round the plant?—Being in rows in these instances they were in straight lines.

8535. You did not mix some of the manure thoroughly with the soil at the beginning?—It would be so, because it was sown in a long trench, and then raked over with a rake so as to mix the soil with it.

8536. In the first experiment you say "slight trace"; was that too small to be estimated?—Yes; it was too small to be estimated.

8537. In No. 12 you say "very faint trace of arsenic"?—That very faint trace of arsenic would be like one of the faintest tubes you had before you this morning. I should not attempt to make a quantitative statement, on a mirror, at all events, not less than that. Those mirrors fade very quickly unless the tube is sealed off when containing hydrogen, and even then I find they fade somewhat.

8538. This mirror is one of the cases which you would term a very faint trace?—Yes. I should not venture to estimate that mirror. And yet there might be an estimation given, but if so that tube has faded since it was made, or I should think so.

8539. (*Sir William Church.*) This was not sufficient to be estimated. This is from one of the Californian fruits?—That would be my report on it.

8540. (*Chairman.*) In respect to August 5th, Nos. 21 and 22, about how much barley may have been tested?—50 grams of the barley and 50 grams of the oats.

8541. In No. 29 was that a later crop of broad beans than those examined on July 1st?—No, the same plants, but on the 1st July the plant is spoken of there as "young and green; nearly fit for the table." On the 3rd September pods and seeds were taken and cut up together, when I obtained one part in thirteen million. And the ripe bean was taken on the 3rd September with the view of strengthening, or otherwise the then arrived at conclusion in our minds that none of the ripened grains of any kind had assimilated arsenic, and we found that was so with the broad beans. If we had taken the broad beans separately on July 1st the probability is that we should have found no arsenic. I cannot prove it this season.

8542. But the same seeds showed no arsenic after ripening?—Quite so.

8543. What became of the arsenic they had in them?—There is no evidence they had any at all. I took pods and seeds together. With my experience now I have a strong opinion that there was none in the seeds themselves at that time.

8544. And that it was in the pods?—Yes. If you will notice, on the 1st July it is broad beans, pods and seeds; but on the 3rd September it is ripe seed.

8545. The inference you draw is that probably it was in the pods?—That is my own opinion now. arsenic in pods;

8546. And probably what you examined on the 1st July did not contain the arsenic in the seed?—Not in the seed.

8547-51. One part in thirteen million: does that mean thirteen million parts of solution made, or thirteen million parts of substance taken—seeds and pods, for instance?—Substance taken.

8552. (*Sir William Church.*) With regard to July 31, No. 20 green peas, was that only the pea or the pea and pod?—Only the pea; not the pod in this instance.

8553. Then I think "no pods" should be put in so as to make that, comparable with the peas?—I think that should be done. But you see one's experience was not comparable at that time.

8554. (*Sir William Church.*) Quite so; but I only wanted to know whether you took the pods and peas as well?—No.

8555. (*Chairman.*) What are your conclusions on the whole of your experiments?—The result of our experiments, which have been carried as far as one season will permit, goes to show that the roots of plants are capable of taking up arsenic from soils manured with arsenicated phosphates. From the roots the arsenic can rise in the fibro-vascular bundles by a process of suction and capillarity, and may be present in measurable quantities in the early stages of succulent growths. Arsenic was found in rhubarb petioles and leaf blades, and in the young leaves or grass of rye and buckwheat, and in the stems and leaves and green pods of broad beans. There you see I have stated green pods as a matter of opinion really because the green pods were never taken alone, and it remains for that to be done. I think it must be looked upon as an opinion, that it was in the pods and not in the broad beans. That being so, in no instance was the faintest trace of arsenic present in the fruit or seed of any plant. in roots and young leaves; none in fruit or seed of any plant examined.

8556. Can you suggest any explanation of that?—It thus appears that in those parts of the plant which are remote from the influences of mere mechanical forces, and where vital or physiological energies predominate, a selective power is brought to bear, and arsenic, even if present, is rejected.

8557. So that you think the arsenic may be excreted?—Refused at that point where starch grains are being formed and other truly physiological processes of an intricate character. We are of opinion that even if the arsenic reaches that point a refusal takes place, and excretion in some form or other.

8558. And in no instance was the faintest trace of arsenic present in the fruit or seed of any plant?—In no single instance.

8559. It seems that in cabbage and in maize there was no arsenic found at all; even in the petioles?—The young leaves of cabbage and maize were free from arsenic.

8560. But the young leaves of other vegetables were not free?—Not in all instances. The young leaves of rye and buckwheat, and the stems and leaves and green pods of broad beans yielded arsenic.

8561. (*Sir William Church.*) What becomes of arsenic when you add it to the soil?—Do you mean what changes take place chemically?

8562. No. For instance, your arsenicated manure which is supplied to the soil; would you be able to recover the arsenic after a good many months?—That was one of our experiments.

8563. No. You said you found the soil still contained arsenic, but I am wanting to know what becomes of the arsenic? Could you recover the whole of the arsenic?—One would not anticipate that possibility. There must be some loss from rains which carry the arsenic right down into the soil. We wanted to see that we put sufficient arsenic to take care of that.

8564. You have not turned your attention to the fact whether arsenic after a time enters into any soluble

condition in the soil?—It was soluble in the soil at the end of the experiments; it was dissolved out with cold water.

8565. You have settled the point so far that there was still, in the soil you were experimenting with, soluble arsenic, but you did not go further to see what quantity of your arsenicated manure had disappeared during the course of your experiments?—It is hardly possible unless we commence with that object in view, and knew the quantity of soil we had added the manure to.

Form in which arsenic taken up by plant.

8566. In what form would you think arsenic is taken up by plants?—I should be inclined to believe that the arsenic is dissolved as a sulphate or in the excess acid of the superphosphate; but I have no evidence of that and I do not know. What I wanted to prove was whether arsenic could find its way through the building up powers of the plant. I should not expect to find the oxide existing as such in a superphosphate at the temperature at which superphosphates are made in the presence of an excess of sulphuric acid.

8567. You would not find arsenious oxide free?—No.

8567*. But you have not formed any opinion as to what especially it is that is soluble and passes into the plant?—No, I have not.

8568. (*Chairman.*) It might pass into the plant, into the root and sap, and yet not be assimilated by the plant?—That is my point, that it does enter with all other soluble matters through the spongioles of the roots, and finds its way through the bundles of fibres in those succulent forms of plants in which the arsenic was found. But immediately the powers of assimilation come into work—which is not the case I take it in the mere tubular portions of the stalk of a plant—the physiological functions take the ascendancy: as soon as it becomes a question of forming the germ of the new plant in the seed. Then there is the power brought in which I am satisfied in my own mind is a sufficient safeguard against the entrance of arsenic into barley or any other seed of a similar nature.

Such arsenic not necessarily assimilated.

8569. Everything that comes up in a sap must remain in the plant; the sap does not come down again. Whatever is in the sap remains in the plant?—Quite so.

8570. Is there any security that it will not get into the grain if it is in the plant?—It has not done so in any of our cases.

8571. In the case of rye or oats or wheat, do you think that there is arsenic in the leaves and blades, but not in the grain?—Not in the grain. We have found it not always, but in many cases in the leaves, especially in the younger growth of the plant. We have found it in the leaves and stalks; not in any instance in the ripe fruit or seed.

8572. Have you found it in sufficient quantities in the blades, for instance, to make hay or straw poisonous for cattle?—It is a point that has not struck me at all. When I have been talking about grass it has not been meadow grass. It has been rye certainly.

8573. The question of the safety of arsenicated manures would not be altogether settled even though it were proved that no arsenic gets into seeds?—Not for grazing, because I found on the "29th June, rye grass in green ear. Upper parts of stems and ears only; faint trace of arsenic." Therefore your question leads one to be cautious not to say that this proves that the use of arsenicated manures can in no form injure the cattle that feed upon the products.

8574. Suppose arsenicated manures were applied to meadow land to be used for grazing. Might arsenic get into the beasts and make their flesh poisonous to mankind?—I should hardly expect to find that, but upon principle, at all events, it is an objectionable practice to allow any cattle to graze upon a plant in which you know arsenic is present.

8575. With all your experience as public analyst and your chemical and physiological knowledge, do you think that for the safety of the public it is necessary that chemical manures should be carefully examined?—No. I do not. I do not think that the result of our experiments lead us to that. We took 22 phosphates, and examined, and found arsenic in all of them, and they varied very little, and the usual quantity was ·03 per cent. of the weight of the manure.

Amount of arsenic in commercial superphosphates much less than in experimental manures.

8576. These were the ordinary manures of commerce?—These were the ordinary manures of commerce. The 22 samples came from three factories and were all labelled with the percentage of soluble phosphates. So that they were not all one batch.

8577. Did you find nearly the same proportion in the different factories?—Very nearly.

8578. Did you find any individual samples in which there was considerably more?—Not a great variation; not sufficient for us to have taken a particular note of any particular sample.

8579. ·03 is a large percentage?—Yes, it is.

8580. ·03 is 3 parts in 10.000?—Yes.

8581. That seems a large amount. Is that in parts by weight of the phosphate?—In parts by weight of the entire phosphate.

8582. For your experiments you added arsenic to the extent of 17 times as much as that?—Yes.

8583. And that did not introduce large quantities of arsenic into the plants in any case?—And that did not introduce large quantities in any case.

Differences in results as regards different plants.

8584. (*Sir William Church.*) Granting that the arsenic in whatever form it may be passed into the plants through the spongioles by a sort of capillary attraction, how do you explain that it is present in some plants and not in others? Cabbages seem to be quite free?—If you remember, the growth of the cabbage is an extremely small root as compared with the size of the plant, and the stem of the cabbage is of a very hard woody nature. The cabbage, although succulent in the leaf, is very woody in the under parts, and that is one reason why I did not get it in the cabbage, I believe.

8585. Maize has a small root, but it is a very succulent free open growing plant. There is no arsenic in the tops of maize and no arsenic in the green maize cob with sheath?—We should not anticipate that a plant which might take up arsenic would necessarily do so in all instances. There must be a chapter of accidents surrounding the question of whether or not that particular spongiole does come at all in connection with the arsenicated manure even. It may happen that it would not be. I should anticipate that it would be.

8586. I am only going with regard to your theory that when physiological action in a plant is more advanced, then there comes in the power of rejection and selection. Carrots do not seem to have had any trace of arsenic in them?—No. I quite expected to find it, but it was not there. I want to point out that the carrot is not a fruit.

8587. It is a root?—Yes. The carrot seed if I had grown it as seed would not have had any arsenic in the seed, even if arsenic was present in the root.

8588. But the root has no arsenic in it?—No.

8589. And mangold you tell us had none?—No.

8590. There, again, that is a very succulent plant, containing a large quantity of aqueous matter?—Yes. It seems to be somewhat opposed to the results obtained, but the results obtained in other instances you see have been always straight stem plants, which would have capillary tubes much more easily accessible possibly than the same tubular structure of the root. But, of course, that is theory.

8591. Where were these experiments carried out?—They were carried out by myself and my son in my own laboratory at Southampton.

8592. I mean the growth of the plants?—They were all carried out within three or four miles of my own place.

Places of experiment.

8593. All on the same plot of ground?—No, not at all. That is a very important point, of course. Those that were taken by myself were in my own kitchen garden. Those that were taken by Messrs. Toogood and Son and treated were carried out between four and five miles away from the ground I operated upon myself, and then a third, a Mr. Sawyer, had his ground about half-way between the two. There were three different positions. Sawyer's ground was on the top of a considerable hill, and a more stony soil than the rest. Toogood's experimental grounds are down in a loamy valley and my own is some stiff clay soil.

8594. I take it that probably the rhubarb, the peas, and the beans, would be carried out in your garden, and the corn would be carried out in one of the other places?—The rhubarb, peas, beans, and cucumber, were our home growth. The cabbage, barley, buckwheat, maize, were grown by Sawyer, and the rest, the roots, were grown by Toogood.

8595. You did not get corn from two different localities?—No. All the corn came from Sawyer's ground.

8596. You heard the evidence, I think, of Dr. Reynolds, when he told us that he had been told by those

who had been analysing hair and other substances for arsenic, that there was very great difficulty in cleansing the flasks. Have you found that?—That is not in accordance with my experience. Of course, the usual drastic and careful cleanliness must be attended to. It would not do to continue a thing in a flask. Nearly the whole of these experiments were done in one flask, and we have a great many more negative results than positive ones, and the positive ones are interspersed amongst the negative ones from the same flask. I was struck at the time when I heard the evidence that it was not in accordance with our experience.

8597. Have you any suggestion to make with regard to the difference?—I should not like to make the suggestion that dawns on my mind. There is more risk of positive results than there is of negative results through the whole of these experiments. It wants very great care to get negative results. If the arsenic is present, any ordinary fairly skilled analyst can find it.

8598. But is it not possible that you may get negative results from want of sufficient care in carrying out your experiments?—I think that is covered by my remark that an ordinary careful operator would be sure to find it if it is there. I cannot see why not.

8599. (*Dr. Whitelegge.*) Can you say how much superphosphate is usually put upon the land? I am told about 4 cwt. per acre?—Yes. That is a liberal but still an ordinary quantity to use.

8600. That works out at about 2,000 grains of arsenic to an acre, taking your estimate of ·03?—Yes.

8601. Or half a grain of arsenic per square yard?—Yes.

8602. Can you say what the length of your hydrogen flame was?—It is kept under control. The length of the flame should not exceed the size of a barleycorn to work well. I do not like a fierce current; that is a dangerous thing.

8603. You did not measure, nor was it possible to measure in the experiment, the amount of manure. You did not put so many grammes of manure near so many plants?—No.

8604. Did you measure the distance away at which they were put?—It would be something like two inches.

8605. Was there uniformity of condition as to watering or washing by rains?—Notes were taken as to the rainfall. I have not them here, but I can send them to you in a general sense whether it was wet weather or dry.

8606. It was not possible to make any estimate of the amount of arsenic that was or might have been absorbed by the roots of a given plant?—No.

8607. Therefore, it would be useless to attempt to measure the amount of arsenic which reached the plant?—Quite so.

8608. Still you found it in some of the tissues, and more especially the succulent tissues?—Yes.

8609. In a form demonstrable by the methods you used?—Yes.

8610. In pursuing that analysis you oxidise the organic matter?—Yes, to a certain extent. In some instances.

8611. You failed to find any at all in the seeds, either green or ripe?—Yes. The question of the bean is *sub judice*.

8612. Exactly. Your view is that there is none in the seed?—Yes.

8613. That is just the point is it not, at which phosphorus is ordinarily assimilated?—Yes.

8614. So that in your view the behaviour of arsenic is precisely the reverse of phosphorus?—That is to say the behaviour of the plant towards it?—Yes.

comparison with phosphorus.

8615. The phosphorus in the seed enters into a new form of combination does not it?—Certainly.

8616. Which possibly might give a different result in analysis?—Yes.

8617. Might not the same sort of thing happen in the case of arsenic? Do you think it is perfectly clear that if you had oxidised the whole of the organic matter in the seed you might not have found some arsenic there?—It is a point of a considerable amount of interest; but I have not tried it.

8618. If you are pursuing these investigations it might be worth considering?—I think so; that is to say would you insist upon an entire destruction

8619. I am thinking of the evidence we have had, that conceivably, under certain circumstances, arsenic may enter into organic combination with some thing or another and hide itself in so doing?—You would be satisfied if the entire mass of the seed was broken up and decomposed if we obtained by this process a mirror of arsenic. Supposing I oxidise my organic solution from the seed entirely or nearly entirely, would you be satisfied then if I got a negative result?

8620. What you have said already is a strong suggestion of absence, but that would strengthen it, to my mind?—I shall certainly make a point of finding that out. I am very much interested in the point myself.

8621. (*Sir William Church.*) You have paid great attention to these questions. Would it not be possible to grow plants in arsenic-free soil in pots and water with known quantities of arsenic manure, and see if they did take up larger quantities into their tissues in proportion to the amount of arsenicated manure they were supplied with?—That would be possible.

8622. That seems to me almost a more satisfactory experiment?—The great bulk of the arsenicated fluid would have to be put on in solution.

8623. (*Dr. Whitelegge.*) Would it not be a more convincing way to take a sufficiently diluted solution of arsenic, and simply water the plant?—Yes, simply take a solution of arsenic and water your manure for the purposes of the plant growth.

8624. (*Sir William Church.*) I only throw that out as a suggestion. It is like the demonstrations given to you of the value of other salts, potash and soda salts?—Now would be the time to commence those experiments. It would be very interesting to work them out. I do not know whether we should get quantitative results that one could very well rely upon, because the bulk of the arsenicated fluid at all events would pass through the pot, would it not?

8625. No doubt?—Would you have to catch that and put it through again?

8626. I should put the pot in a saucer. You may get it so concentrated at last that the plant would die?—That was a point I was thinking of. Your observation is one I will take note of.

8627. If you found in your dying or dead plant that there was a very large percentage of arsenic present in its tissues, it would not invalidate the experiment?—No, not at all.

TWENTIETH DAY.

Friday, 21st March 1902.

AT 8, DELAHAY STREET, WESTMINSTER

PRESENT:

The Right Hon. Lord KELVIN (*Chairman*).

The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Professor THORPE.
Dr. WHITELEGGE.
Dr. BUCHANAN (*Secretary*).

Mr. H. H. Smith.

21 Mar. 1902.

Mr. H. HAMMOND SMITH, called; and Examined.

3628. (*Chairman.*) You present this report, which has been sent to us?—Yes.

REPORT by Mr. H. Hammond Smith on Alleged Cases of Poisoning, attributed to Arsenical Beer, at Halifax.

Outbreak of arsenical poisoning at Halifax, 1902.

In view of statements in the "St. James's Gazette" of January 7th, 1902, and also in the "Daily Mail" of January 13th, to the effect that a man, McNulty, had died in the Halifax Infirmary from arsenical poisoning supposed to be due to beer drinking, and that other cases were in the Infirmary suffering from similar symptoms, I received directions from the Commission to make local inquiries.

On January 15th, 1902, I went to the Poor Law Infirmary, Halifax, where the alleged cases of poisoning were under treatment. Here information was given me by Dr. W. Shaw and Dr. Woodyatt (visiting Medical Officers of the Infirmary), by Dr. Hodgson (resident Medical Officer), and by Dr. West Symes, who was representing the interests of the Halifax brewers. I found that altogether there were then in the Infirmary four suspected cases of arsenic beer poisoning, in addition to McNulty, who had died.

Cases in Halifax Infirmary.

I may here state that subsequently two other cases were admitted, one of whom (T. Lee) has since died, and that, in addition to these seven Infirmary cases, a few others have been heard of in Halifax which have been treated at their homes. To these I will allude below.

At the date of my first visit, an inquest which had been ordered by the Halifax Coroner on McNulty was adjourned pending inquiries instituted by the Coroner, and I attended the adjourned inquest on January 23rd.

Inquest on McNulty.

Dr. Hodgson had stated at the previous sitting that, as a result of clinical observations which I note below on the next page, he had formed the opinion that death was due to arsenical poisoning attributable to drinking beer, and that the man also suffered from a fatty heart, bronchitis, and hypostatic pneumonia.

At the adjourned inquest Dr. Woodyatt, the visiting Medical Officer, said that in his opinion the cause of death was bronchitis and heart failure, and that arsenical beer poisoning, if any, had no concern in the fatal result. He claimed in particular that the pigmentation was not arsenical. Mr. Allen, Public Analyst of the Borough of Sheffield, etc., and a member of the Joint Committee of the Society of Chemical Industry and Society of Public Analysts which has investigated tests for arsenic, was called, and gave evidence as to analysis of post-mortem specimens from McNulty, which had been sent him by the Coroner. He had found arsenic in minute amounts in the liver, viz., 1-700th of a grain in from three to four ounces of liver substance. He had also found about 1-400th of a grain of arsenic in the contents of a jar containing portions of other viscera, mainly pieces of small intestines and left kidney.

Arsenic in viscera.

Mr. Allen also gave evidence as to certain beer samples taken by the Coroner's officer from public houses frequented by McNulty.*

In these he had found the following amounts of arsenious oxide:—

Arsenic in Halifax beer.

(a) In beer from the "Britannia" Inn, 1-18th of a grain per gallon.

(b) In beer from the "Black Horse" Inn, 1-24th of a grain per gallon.

(c) In beer from the "Brewers' Cellar," 1-16th of a grain per gallon.

The brewers who supplied the above public houses were respectively:—

(a) Messrs. Webster and Sons, Halifax.

(b) Messrs. Ramsden, Halifax.

(c) The Yorkshire Brewery Company, Leeds.

Mr. Allen exhibited Marsh mirrors obtained from the beers submitted to him, and also his standard mirrors. In the end, the jury returned a verdict of "Death from natural causes, accelerated by bronchitis."

In view of the above indications I continued my inquiry on several dates in January and February, with the view to discover the origin of the beers associated with the cases and the opportunities of their contamination by arsenic. In the first instance I called on the medical officer of health of Halifax, Dr. Neech, who told me that these cases had not been reported to him by Dr. Woodyatt or by Dr. Hodgson, and that the first intimation of them he had was through the coroner. At the date of my first visit the matter had not come before him in such a way as to indicate the need for special inquiry, but subsequently he has not only given much ready assistance to me as representing the Royal Commission, which I would gladly acknowledge, but also he has himself made a series of investigations on parallel lines, the results of which I understand he is about to submit to the Sanitary Committee of the Town Council in a Report, a copy of which he has also undertaken to transmit to the Commission.

Action of Halifax M.O.H.

In February Dr. Neech sent a letter of inquiry to medical practitioners in Halifax, asking to be informed of cases of alcoholic neuritis or of suspected poisoning by arsenic in beer. Up to the present Dr. Neech informs me that four such cases in the private practice of medical men in Halifax have been heard of. Whether these four cases, together with the seven in the infirmary, represent all the recent illness possibly attributable to arsenical beer in Halifax I am unable to say. In view of the recent inquests and of the association of the disease in the public mind with persons of the ne'er-do-well, heavy drinking class, it is possible that medical men may hesitate to involve their patients in the risk of being associated in inquiry of this kind.

* The Coroner's officer took samples from these public houses in bottles. From them the Coroner filled smaller bottles for Mr. Allen's examination. The remaining portions he has since given to me, and I have forwarded them to Professor Thorpe.

Mr. H. Smith. 21 Mar. 1902.

At the date of my visits only one of the four above cases were brought to my notice, a man F, and this is the only case, other than those in the infirmary, which I have dealt with in this report.

INFIRMARY CASES.

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The Poor Law Infirmary is quite a new building, being opened to patients only at the end of last year. Three of the cases had been brought there from the old Halifax Workhouse Infirmary, in which they had previously been under treatment.

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Case No. 1.—William McNulty, aged 84, man of the tramp class, admitted on the night of January 4th, 1902. Symptoms on admission, according to Dr. Hodgson: Suffering from bronchitis. Dropped feet; absence of knee jerks; pain on pressure in the calves; pains in the feet. Face and feet puffy; running at eyes and nose; voice husky. Heart dilated; irregular pulse. Extremely weak; no appetite. Tongue silvery. Temperature not above normal. General pigmentation of the skin of trunk and extremities, well marked in places, and in appearance characteristic of arsenical pigmentation. This man rapidly grew worse, and died on January 8th. At a post-mortem examination made by Dr. Hodgson, in the presence of Dr. Woodyatt, the heart was found dilated and showed fatty degeneration; the lungs showed evidence of bronchitis and "hypostatic pneumonia." Liver normal in size, but fatty and friable; kidneys, slightly cirrhotic; capsule adherent; spleen soft; abdominal glands and suprarenals normal. The result of analysis of viscera has already been given.*

This man had been a heavy beer drinker; he spent seven months out of the twelve in Halifax, where, I am informed by Mr. Crawshaw, the chief meat and food inspector, he chiefly frequented the Britannia Inn, supplied by Messrs. Webster and Son. He had been staying at Halifax and frequenting this public-house for some months before his admission.

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Case No. 2.—George Shearing, shoemaker, age 61, admitted November 14th, 1901, into the old Workhouse Infirmary (where he was treated on the supposition that he suffered from Bright's disease), and shortly afterwards transferred to the new Infirmary. Symptoms on admission there:—Marked pigmentation of skin of the trunk and neck with clear patches; keratosis of the feet and scaly condition of the lower part of the legs. Loss of power in all four extremities; unable to walk; knee jerks absent; hands clenched; legs flexed. Puffy face; very husky voice; eyes running; seemed muddled when spoken to; and generally very weak. On January 30th, when I saw this case, the above signs and symptoms were apparent and the keratosis was particularly well marked.

This man was a heavy beer-drinker, getting all his beer at a public-house called the "Cross Keys" in Halifax.

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Case No. 3.—L. Whalan, 65, wire cleaner, admitted to infirmary January 10th, 1902; stated on admission that he had a "feeling of electricity all over him" for eleven weeks; and that his feet had been swollen and painful so that he could not stand. Skin slightly mottled, but no obvious pigmentation; some peeling of skin on feet and hands. Loss of power in extremities; no tendon reflexes; slight dropped foot; complaining of numbness and tingling of hands and feet; anaemic; heart sounds weak. Although there was no doubt peripheral neuritis in this case, I did not think when I first saw him that there were any clinical appearances affording strong grounds to suspect arsenic as a cause. Since my first visit, however, Dr. Hodgson has on more than one occasion found arsenic in this man's urine by Reinsch's test. On my second visit on January 30th, the peeling and scaliness of the palms and soles had become more marked, amounting to keratosis. The man did not appear to have improved. This man had been a fairly heavy beer-drinker, and up to eight weeks before his admission (when he is said to have given up beer-drinking because it made him sick), he had been drinking as much as five pints or even more a day. His beer was obtained almost solely from the "York Inn" supplied by Messrs. Whitaker.†

* I may note that taking the quantity of arsenic found in 4 oz. of liver at 1-700th of a grain, and the weight of the liver as 53oz., there would be about 1-60th of a grain in the whole liver. This result is not dissimilar to those obtained by Dr. Stevenson and Dr. Dixon Mann in fatal cases in Manchester in 1900.

† Note by Witness (April 18th).—See, as to this, Evidence by Mr. G. S. Thompson (*q.* 8849), and by Dr. Neech (*q.* 9093).

Case No. 4.—Nancy Wilkinson, single, silk spinner, aged 35. Admitted 8th October, 1901, into the Workhouse Infirmary. She came from Brighouse, a district which is outside Halifax, but comprised in the Halifax Union, and stated on admission that she had been suffering from "rheumatism." Symptoms were: Much pigmentation of skin of the trunk (according to Dr. Hodgson, a "typical arsenical" condition), inability to walk, no tendon reflexes, pain on pressure of the calves, dropped feet, complaining of having had "pins and needles" in extremities, keratosis of soles of feet. *Mr. H. H. Smith.* 21 Mar. 1902. Wilkinson.

This woman is now improving and on January 30th was in a convalescent ward.

This woman had the appearance of an habitual beer drinker, and obtained her beer from the "Black Bull," at Brighouse, supplied by Messrs. Ramsden.

Case No. 5.—Mrs. Lowrie, widow, aged 50, admitted October 29th, 1901, to old Workhouse Infirmary, and shortly afterwards transferred to new Infirmary. Symptoms on admission to the latter: Marked general pigmentation of skin all over the trunk with clear patches, particularly around the waist. Complaining of pricking sensations and pains in the feet, knee jerks present, no obvious paralysis, no keratosis, but skin generally somewhat scaly though smooth to touch, some bronchitis. At the date of my visit the above symptoms were present; the woman was stated to be improving. I am informed that in March she developed definite keratosis. She was a thin, wasted-looking woman, and stated she was practically a teetotaller, but told me that she took a gill of porter at times, and sometimes a glass of beer. I subsequently heard through Dr. Neech that this woman's landlord has often seen her taking beer at home, obtained from the "Victoria and Albert" public-house. Lowrie.

Case No. 7.—T. Lee, carter, aged 54. Admitted January 15th, 1902. Symptoms on admission: Very well marked pigmentation of the skin all over his body, typically arsenical, and with an almost metallic lustre between the shoulder-blades, silvery tongue, husky voice, dulness of upper lobe of left lung, rales to be heard all over chest, systolic murmur heard all over heart area. Reflexes slow, gait ataxic, sick in the morning; suffering also from stricture, which required surgical relief, and incontinence of urine; eventually he showed signs of heart failure, with abdominal breathing, due to paralysis of diaphragm (?), ineffectual cough; on February 4th the intercostal spaces were sucked in. The temperature was very irregular. Lee.

On January	15th	it was	97·2.
„	23rd	„	98·4.
Night of	24th	„	99·6.
Morning of	25th	„	98·6.
Night of	25th	„	100.

gradually rose to 102 night of 28th, then having a morning rise to 101·4, and night fall to 99 till February 1st; on the night of February 2nd it rose to 103, and then gradually fell till he died on February 5th.

Dr. Hodgson had found arsenic twice in this man's urine on January 21st and 22nd. He died on February 5th, 1902. At an inquest held on February 7th, a verdict was returned of "Death from pneumonia accelerated by arsenical poisoning." A post-mortem examination was made. Inquest on Lee.

From notes by Dr. Woodyatt and Dr. Hodgson, I gather that the principal appearances were:—Lungs; Consolidation of the whole of upper lobe of right lung, which presented appearance of grey hepatisation. (There seems to be some uncertainty whether this consolidation was recent, Dr. Woodyatt regarding it in this light, while Dr. Hodgson pointed out that in his view this mischief was of longer standing, and organisation was taking place, an opinion which receives some confirmation from a report on microscopical examination of a specimen sent to Professor Delépine). In lower lobe signs of "hypostatic pneumonia." Fatty degeneration of heart muscle (Delépine), atheroma of aorta and aortic valve. Liver large and fatty. Kidneys slightly cirrhotic, with pelves dilated. Suprarenals normal.

The viscera were not examined chemically in this case.

Case No. 8.—H. Marsden 50, admitted from Norland, a district just outside the borough, January 17th, 1902. On admission face blotchy and puffy, eyes and nose running, feet swollen, red, and painful, particularly when warm. Pigmentation around nipples where pigmented skin was peeling. Tendon and superficial reflexes exaggerated, calf muscles very tender, slight bronchitis. Some incontinence of fæces and urine. Dr. Hodgson Marsden.

Mr. H. H. Smith. 1 Mar. 1902.

found arsenic on three occasions (January 19th, 22nd, and 24th) in this man's urine. On February 14th this man was discharged from the hospital by Dr. Woodyatt, and so is no longer under Dr. Hodgson's observation. At the date of his discharge distinct keratosis had developed.

Case in Private Practice.

Private cases.

Case 6.—This case was shown me by a medical man, Mr. F., aged 45, no occupation; first seen by Dr. Leech, December 27th, 1901. Always been a big drinker, but lately has been drinking heavily of beer from the "Cross Keys" public-house. His custom was to have three or four pints in the morning, sleep the greater part of the afternoon, and to have a further three or four pints in the evening. His symptoms when I saw him were: Well-marked pigmentation of skin, especially on the face, of a well-defined "pinhead" character; hand grip weakened, loss of power in extensor muscles, tottering gait, tenderness on pressure in the calves, slight keratosis, liver enlarged and slightly nodular, some recent œdema of the legs, failing memory.

Review of Above Cases.

Outbreak one of arsenical poisoning.

Taking all the symptoms of the above cases into consideration it is clear that clinically, and especially in respect of affections of nerves, they present almost identical features with those of the sufferers from the 1900 epidemic as described to the Commission by Dr. Reynolds, Dr. Nathan Raw, and others. Pigmentation, upon which stress has been laid as demonstrating the arsenical origin of a case not otherwise to be distinguished from one of "alcoholic" neuritis, was observed in several instances, and the character of this pigmentation was the kind particularly associated with arsenic. Marked keratosis, again, which was a common symptom in the Manchester cases, and which may be considered specially indicative of arsenic, was observed in six cases, Nos. 1, 2, 3, 4, 6, and 8. Arsenic was detected by Dr. Hodgson in the urine of three cases, and specimens of urine from the same three cases were sent to me by Dr. Hodgson and transmitted to Professor Thorpe, who has confirmed the presence of arsenic in two instances, although the amount was minute. In the only case in which chemical examination has been made post mortem, arsenic has been found in the liver and in other viscera.

I may note that Dr. Hodgson, who has recognised the probable nature of these cases, had made a careful study of the cases which occurred in Crumpsall Infirmary during the epidemic in Manchester in 1900. Last month Dr. Reynolds, at Dr. Hodgson's request, examined these Halifax cases, and as he has already informed the Commission, he was satisfied on clinical grounds that they were attributable to arsenic. The cases in the infirmary, as has been said, were seen and treated by Dr. Hodgson in his capacity of resident medical officer; but they were also, in the hospital sense, under the care of the visiting medical officer, Dr. Woodyatt. Dr. Woodyatt did not agree at first with Dr. Hodgson that poisoning by arsenic in beer was the cause of illness in these cases, and at the first inquest (McNulty) this difference of opinion was made very patent. At the second inquest Dr. Woodyatt informed the coroner that, although he had suspected arsenical poisoning in Thomas Lee during life, the post-mortem appearances had made him alter his mind, and that he was satisfied that the cause of death was croupous pneumonia. Dr. Hodgson, on the other hand, said that the condition of the lung in his view could be sufficiently accounted for by weak action of the heart, which again might be attributable to arsenical poisoning.

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None of these patients had been taking arsenic medicinally, so far as could be ascertained, before onset of illness. None of them were exposed to arsenic by reason of their work. As has been said, all beyond question were beer drinkers, and some consumed heavy quantities of beer habitually.

Sources from which the Above Patients Obtained their Beer.

Beers implicated.

From enquiry which I made of the patients, and from information supplied to me by the chief sanitary inspector of Halifax, and by Dr. Hodgson, it appears that the places from which the above cases habitually obtained beer shortly before onset of illness were as follows:—

Case 1.—"The Britannia" (Messrs. Webster).
"The Brewer's Cellar" (The Yorkshire Brewery Company).
The "Black Horse" (Messrs. Ramsden).

Case 2.—"Cross Keys" (Publican-Brewer).

Case 3.—"York Inn" (Messrs. Whitaker).*

Case 4.—"Black Bull," Brighouse (Messrs. Ramsden).

Case 5.—"Victoria and Albert" (Messrs. Alderson).

Case 6.—The "Cross Keys" (Publican-Brewer).

Case 7.—"Three Pigeons" (Messrs. Webster).†
"The Druids" (Messrs. Whitaker).
"William the Fourth" (Messrs Ramsden).

Case 8.—"Moor Cock" (not a tied house, but supplied chiefly by Messrs. Whitaker).
"New Rock" (Messrs. Whitaker).‡
Another public-house (Messrs. Ramsden).

Thus two patients, 1 and 7, had each consumed beer derived in part from Messrs. Webster; three cases, Nos. 3, 7, and 8, beer from Messrs. Whitaker, one of these, No. 3, being supplied almost wholly from this brewery; No. 5 obtained beer almost wholly from Messrs. Alderson; case No. 4 obtained beer solely, and cases 1, 7, and 8 partly, from Messrs. Ramsden; while two cases (No. 2 and 6) obtained beer almost wholly from the publican-brewery, the "Cross Keys."

Local Enquiries and Action with regard to above Cases.

Dr. Neech informed me that in 1900 he had suspicion of arsenic having been present in beer from one brewery in Halifax, but this beer was recalled by the brewers before a sample could be obtained. The brewery in question, Messrs. Brear and Brown, is understood to be the only brewery in Halifax which in 1900 was obtaining brewing sugars from Messrs. Bostock. Since that date until recently Dr. Neech has never had occasion to suspect arsenic in Halifax beer.

At the date of my first visit Dr. Neech had not taken any steps to trace the actual beer associated with the cases, but he had caused certain samples of beer on sale at public-houses in Halifax to be collected as follows:—

Notes by Witness, April 18th, 1902.

* *See* note on p. 15.

† In draft of this report the words Whitaker and Webster were accidentally transposed. *See* Mr. G. S. Thompson's evidence, Q. 8851–2.

‡ I have since been informed that Messrs. Whitaker do not own the "New Rock." *See* Mr. G. S. Thompson's evidence, Q. 8854; and Dr. Neech, Q. 9095.

From 13th January to 16th January.

Date of Collection of Sample.	Name of Inn.	Name of Brewer.	Number of Sample.
13 January 1902	"York Inn"	R. Whitaker and Sons	162
13 „ „	"Victoria and Albert"	Alderson's	163
13 „ „	Grocer, Mr. Fox	Whitaker's	164
13 „ „	"The Peacock"	Brear and Brown	165
14 „ „	"Cross Keys"	Swift's	166
15 „ „	"Cross Keys"	Swift's	166a
16 „ „	"Cross Keys"	Swift's	167

The above samples were submitted to Mr. Ackroyd, Halifax Borough Analyst, who reported them free from arsenic in each instance.

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Additional samples were obtained by Dr. Neech's direction on January 17th, 20th, and 21st, viz.:—

Date of Collection of Sample.	Name of Inn.	Name of Brewer.	Number of Sample.
17 January 1902	"Cross Keys"	Swift's	169
17 „ „	"Cross Keys"	Swift's	170
17 „ „	"Victoria and Albert"	Alderson's	1
17 „ „	"York Inn"	Whitaker and Son's	2
17 „ „	"Foundry"	Ramsden's	3
20 „ „	"Cross Keys"	Swift's	174
20 „ „	"Gibbet Tavern"	Webster's	175
20 „ „	"Victoria" (Porters)	Alderson's	176
20 „ „	"Mechanics"	Halifax Brewery Company	177
21 „ „	"Mitre"	Stocks	6
21 „ „	"Wheat Sheaf"	Brear and Brown	7
21 „ „	"Northgate Hotel"	Webster's	8

The above samples were submitted to Mr. Richardson, of Bradford, who reported as follows:—

No. 169, 1-35th grain; No. 170, 1-16th grain (both "Cross Keys" beer); 1, 1-250th grain; 2, 1-250th grain; 3, 1-170th grain arsenious oxide per gallon. Nos. 174 to 177 only very minute traces. Nos. 6 to 8 only very minute traces.

Dr. Neech informed me that samples 169 and 170 were of the same brews as the "Cross Keys," which a day or two before had furnished respectively samples 165—166a, and 167, sent to Mr. Ackroyd and returned by him as free from arsenic.

In the last week in January, after the inquest on McNulty, Dr. Neech again had samples of beer then on sale at public-houses in Halifax collected. He kept these samples for a time as he had hesitation in sending them to the borough analyst in view of the latter having failed to find arsenic in the "Cross Keys" samples submitted to him on January 14th to 16th.

Eventually, with the concurrence of the sanitary committee, these samples were sent to Mr. Allen, at Sheffield. I have now heard from Dr. Neech that Mr. Allen's results are as follows:— Mr. Allen's.

Date of Collection of Sample.	Number of Sample.	Public-house.	Brewer.	Result.
24 January 1902	183	"Duke of Leeds"	Bentley and Shore	1/30 grain per gallon, about.
24 „ „	184	"Prescott Arms"	Yorkshire Brewery Company.	„ „ „ „ „
24 „ „	185	"London Tavern"	S. Webster and Son	1/70 „ „ „ „
24 „ „	186	"Mechanic's Arms"	Halifax Brewery Company	1/30 „ „ „ „
24 „ „	187	"Kimberley Arms"	Boardmans	Free from arsenic.
24 „ „	188	"Mitre Hotel"	Stocks's	No arsenic detected.
24 „ „	189	"Westgate Hotel"	Aspinall, Halifax	1/30 grain per gallon, about.
24 „ „	190	"Peacock Inn"	Brear and Brown	No arsenic detected.
24 „ „	191	"Sportsman Inn"	Ramsden and Son	Sample lost in transit.
24 „ „	192	"Waggoner's Arms"	J. Smith, Tadcaster	No arsenic detected.
24 „ „	193	"New Inn"	Alderson and Company	Free from arsenic.
24 „ „	194	"Hop Pole Inn"	R. Whitaker and Sons, Halifax.	1/70 grain per gallon, about.
25 January „	195	"Ring-o'-Bells"	C. B. Whitaker, Luddenfoot.	No arsenic detected.
25 „ „	196	"Queen's Road Hotel"	Fielden and Company, Halifax.	No arsenic detected.

As one of the cases, No. 4, obtained all her beer at one of Messrs. Ramsden's public houses at Brighouse, outside Halifax, I asked Dr. Martin, the medical officer of health at Brighouse, to make some inquiries. He at once procured samples of beer then on sale from the public house in question, and sent them to Mr. Allen for analysis. They were returned, however, as arsenic-free by Mr. Allen. Dr. Martin has also instituted some inquiries amongst medical men in his district as to suspected cases of arsenical beer poisoning, but so far, I understand, with negative results.

I called on Mr. Ackroyd, the borough analyst of Halifax, on January 15th, and again on the 18th. He informed me that he has during the past year been constantly engaged in testing beers and brewing ingredients for brewers in and around Halifax. Some of the brewers have their beers tested by him every quarter. I gather that as a matter of fact he has hardly ever by the test which he employs found arsenic in any sample of beer or of brewing ingredients submitted to him during the latter half of 1901 or during the present year. The test which he used in all cases is the Reinsch test in the form first advised by the Brewers' Expert Committee in their Report of the 31st December, 1900. With regard to the "Cross Keys" sample, in which he had found no arsenic, Mr. Ackroyd showed me a sublimate which he believed to be the one which he had obtained from the Reinsch copper in one of these beer samples, and told me that in his opinion, although a sublimate had been obtained in this instance, it was not arsenic. He was not however, able to identify the tube in question with any degree of certainty, as it had not been labelled. At the date of my second visit, Mr. Ackroyd was engaged in analysing a large number of samples of beer and brewing ingredients sent to him by the brewers in consequence of the present allegation. The certificates of analyses thus made by Mr. Ackroyd for brewers were produced at the inquest on McNulty, by Mr. Waugh, who stated that the beers examined were absolutely free from arsenic. I learn that since my visit, Mr. Ackroyd has modified his methods of testing, and that he has now adopted the form of Marsh Berzelins test recommended by the Committee of the Societies of Chemical Industry and Public Analysts.

On January 18 I called on Mr. Sergeant, the chief officer of excise at Halifax. He informed me that he had seen the newspaper reports of the inquest on McNulty, but he had not considered it necessary to take any steps in the matter, having received no specific instructions to do so from the Board of Inland Revenue. At that date he had sent no special samples of beer or brewing ingredients to the Government Laboratory to be tested for arsenic; but since then, I understand, a large number of samples of recently brewed beer from Halifax breweries (particularly breweries implicated in respect of the above cases), and also of their brewing materials, have been collected by the local excise authorities and transmitted to the Government Laboratory. Excise officers sent samples from breweries after outbreak.

The suggestion made by Dr. Hodgson at the first inquest that the cases in the infirmary were attributable to arsenical beer poisoning, and the statement by Mr. Allen that amounts such as 1-16th and 1-18th of a grain of arsenic per gallon had been found in beer purchased in Halifax, were at first received by the brewers with incredulity, and, naturally enough, with some hostility. Attitude of Halifax Brewers.

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I am informed that it was intimated on behalf of the brewers that no efforts would be spared in instituting legal proceedings against Dr. Hodgson and Mr. Allen if their statements to the coroner could be confuted. The same incredulity no doubt led certain of the brewers to view with disfavour the action of the coroner, by which attention had been pointedly drawn to these cases; and the coroner at the second inquest on the man Lee on February 7th publicly took objection to a visit which had been paid to him by one of the Halifax brewers before his inquiry. At both inquests the Halifax brewers were represented by a barrister, Mr. Waugh, who in each instance made the most of the view taken by Dr. Woodyatt, that the cause of death was not arsenical poisoning, and at the first inquest laid great stress on the fact that the Borough Analyst had found no arsenic in any sample of beer from the breweries implicated. He also produced certificates of analyses relating to other samples of beer from the breweries in question which stated that they were free from arsenic. The brewers engaged on their behalf the services of Dr. West Symes, of Halifax, who frequently visited the infirmary cases and advised the brewers on medical questions involved. Mr. Buckley (managing director of Messrs. Webster), who is chairman of the local Brewers' Association, informed me that after the suggestion of arsenical poisoning had come to his notice he called a meeting of the principal brewers and advised them to have all their beers analysed. As has been said, in the middle of January such analyses were being made by the Borough Analyst, with the negative results referred to above. Later, in February, I learned that a large number of samples of beer, as well as malt and other brewing materials, were being sent for analysis by Halifax brewers not only to the Halifax Public Analyst, but also to Mr. Richardson, of Bradford; Dr. Luff, in London, and others.

Inquiry as to Origin of Particular Beer Associated With the Above Cases.

Source of beer consumed by sufferers.

On January 23, and on later dates, I visited all the breweries from which particular beers had come under suspicion either by having been found to contain arsenic in noteworthy amounts by Mr. Allen or by other analysts, or by having been drunk wholly or in part by the patients above referred to. My object in each instance was to trace the particular beer, if possible, back to its brew, and then ascertain details of the ingredients used in such brew.

I have to acknowledge my indebtedness to brewers and maltsters for the information which they kindly placed at my disposal.

The breweries in question were:—

(Table 1.) Messrs. Webster (Halifax), who supplied beer consumed (along with that of other breweries) by cases 1 and 7, and whose beer at the "Britannia" Inn was found by Mr. Allen to contain 1-18th of a grain of arsenic per gallon.

(Table 2.) Messrs. Ramsden (Halifax), who supplied beer consumed (along with that of other breweries) by cases 1, 7, and 8, and whose brewery had been almost the sole source of beer taken by case No. 4; and whose beer, also, at the "Black Horse" was found by Mr. Allen to contain 1-24th of a grain of arsenic per gallon.

(Table 3.) Bentley's Yorkshire Brewery Company (Leeds), who supplied beer consumed (along with that of other breweries) by case 1., and whose beer at the "Brewers' Cellar" was found by Mr. Allen to contain 1-16th of a grain of arsenic per gallon.

(Table 4.) Messrs. Whitaker (Halifax), who supplied beer consumed (along with that of other breweries) by cases 7 and 8, and whose beer at the "York" Inn had been almost the sole source of beer taken by case No. 3.

(Table 5.) Cross Keys Brewer (Halifax), whose beer at the "Cross Keys" had been almost the sole source of beer taken by cases 2 and 6.

(Table 6.) Messrs. Alderson's (Halifax), whose beer at the "Victoria and Albert" had been almost the sole source of beer taken by case 5.

In the case of Messrs. Webster and Messrs. Ramsden I was informed by the brewer that his records enabled him to refer with certainty beer, in which Mr. Allen found respectively 1-18th and 1-24th of a grain of arsenic per gallon, to brews of specific dates, made with ingredients the origin of which is recorded in each instance. At Messrs. Webster's, the date of the brew in question was December 13th, 1901; at Messrs. Ramsden's, it was either December 12th, or December 18th, 1901.

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In the case of the Yorkshire Brewery Company, I was informed that though the exact brew from which was derived the sample in which Mr. Allen found 1-16th of a grain per gallon could not be identified, it was one of four brews of December, 1901, all of which were prepared with ingredients of the same origin and in the same proportions. As regards the publican-brewery in Halifax, the "Cross Keys," the brewer had no doubt that the beers in which Mr. Richardson found respectively 1-16th and 1-35th of a grain per gallon were prepared solely from malt, hops, and flaked maize on December 5th and December 27th, 1901, respectively; but he did not keep any book by which this statement could be verified.

As regards Messrs. Whitaker I had no chemical results respecting the beer to go upon, but only the evidence that three patients admitted to the Halifax infirmary in January, 1902, had obtained beer from this brewery; one (case No. 3), almost exclusively; the other two along with beer from other breweries. At this brewery, therefore, I selected arbitrarily for enquiry beer brewed about the middle of December, 1901. Similarly at Messrs. Alderson's, where likewise I had no chemical results respecting the beer to go upon, I took for enquiry the brews of August and September, 1901, which appeared most likely to have furnished the beer consumed at the "Victoria and Albert," by case No. 5, prior to her admission to the Halifax old workhouse infirmary, in October, 1901.

When the particular brews thus selected and enquired into at the several breweries are compared, the results are briefly as follows:—

Source of arsenic in brews inquired into.

Glucose.—Glucose entered in all the brews enquired into except the "Cross Keys." None of the remaining five breweries, I was informed, had ever been customers of Messrs. Bostock. The glucose which had been used was obtained as follows:—

Origin of glucose used;

At Messrs. Webster, from the Liverpool Saccharum Company.

At Messrs. Ramsden, from the Glasgow Sugar Company.

At the Yorkshire Brewery Company, from the Mambré Company.

Messrs. Whitaker, American Glucose, obtained through agents (Ince, Pickering and Company).

Messrs. Alderson, American "Climax" Glucose, through agents, Messrs. Thompson, of London.

Each of these brewing sugar firms supplies glucose to large numbers of brewers elsewhere than in Halifax; and (except at Messrs. Alderson) I saw the invoices, which in each instance guaranteed the products to the brewer as "free" from arsenic. I could obtain no information of arsenic having been found in any specimens of glucose from any of the above firms. On this point no doubt ample information could be furnished by the Government Laboratory.

Invert Sugar.—Invert sugar entered into the brews enquired into at three of the breweries only, and was obtained as follows:—

of invert sugar;

At Messrs. Webster, from Valentine and Tod.
At Messrs. Ramsden, from Fowler and Company.
At Messrs. Whitaker, from Valentine and Tod.*

Invert sugar was added as priming to the brew at one brewery only, namely, Messrs. Whitaker's. No priming of any kind was said to have been used in any other of the brews inquired into.

The above remarks with regard to glucose apply equally to these invert sugars.

It will be noted that the proportions of glucose or invert sugar used at the five breweries in question was, generally speaking, not excessive.

At Messrs. Webster's brewery for instance, the quantity of invert sugar which entered into a gallon of finished beer was .079lb., and the quantity of glucose ·059lb. Assuming that both invert sugar and glucose had contained arsenic and in equal proportions, and that all this arsenic had entered into the beer, then, for the beer to contain as much as 1-16th grain of arsenic per gallon it would be necessary for the glucose and the invert to have been contaminated to the extent of ·45 grain, or nearly ½ grain of arsenic to the pound. The

* Note by Witness, April 18th.—Apparently the source of invert sugar at this brewery was the Liverpool Saccharin Company, not as here stated. See Mr. Thompson's evidence, Q. 8859-8860.

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Commission has not received evidence that any glucose or invert sugar, other than Bostock's, in 1900 or since, has contained arsenic in anything approaching this proportion.

of flaked maize:

FLAKED MAIZE.—Flaked maize was used in the particular brews enquired into at Messrs. Webster, Ramsden, Whitaker, Alderson, and "Cross Keys," not at the Yorkshire Brewery Company. I have met with no evidence that arsenic has at any time been found in samples of flaked maize, either at Halifax or elsewhere, and I understand that no mineral acid is used in its preparation.

of preservatives:

PRESERVATIVES, ETC.—In view of the evidence which the Commission has received as to the very slight degree in which it is possible for beer to be contaminated by arsenic through the use of hardening substances, yeast foods, finings, or preservatives, it is not perhaps necessary here to detail such particulars as I have collected with regard to the use and origin of these materials in the particular brews enquired into, but if the Commission consider it desirable for the sake of completeness, I will do so.

of hops:

HOPS.—I have not as yet made complete enquiry as to the origin of hops used.

and of malt.

MALT.—I could obtain no evidence at the several breweries that in the particular brews enquired into malt of a common origin had been used, or, indeed, that any two of the breweries in question obtained malt from one and the same maltster. Accordingly it is necessary to deal with the malt in each of the brews enquired into separately.

Messrs. Webster.—Visited January 24th and February 13th, 1902. Up to the end of January, 1902, last season's malt, *i.e.*, 1900-1901, was being used exclusively at this brewery, and would have been used in the brew under enquiry, which was made on December 13th, 1901. I was informed that the Yorkshire malt used in this particular brew was made as far back as February 5th to 13th, 1901.

Before February 20th, 1901, no fuel other than Halifax and Barnsley gas coke had been used at Messrs. Webster's maltings. Some foreign malt had also entered into the brew inquired into, and this, the brewer informed me, had been made just after he had, in consequence of the "beer scare," given up gas coke and taken to anthracite. When this foreign malt was made (between March 31st and June 5th) he was using anthracite on the kiln, either solely or with some admixture of gas coke. I saw the invoice relating to the first purchase of anthracite, which was dated February 14th, 1901. Before the fuel was thus changed from gas coke to anthracite the kiln was swept out.

Messrs. Webster's maltings are close to the brewery, and all their malt is screened and once brushed in a Barron's machine at the maltings, which was put up in December, 1900. I was also informed that the February 5th to 13th malt, stated to have been used in the brew under inquiry, had "damped" in the malt bin, and had been redried and again brushed before being used.

Messrs. Ramsden.—Visited February 13th, 1902. The malt used in the beer here enquired into (brewed on December 12th and December 18th) according to the books which were shown to me, was new malt of this season's malting. It was made up of malt coming from Messrs. Ramsden's Elland, Brighouse, and Caulder maltings. I visited the Brighouse and Elland maltings of this firm. At each malting I was informed that the fuel used this season has been oven coke and anthracite. The brewer put the proportions as two-thirds of oven coke to one-third of anthracite, but the maltster spoke of anthracite and a "little" oven coke. At both maltings, however, I was informed that last season, 1900-1, a variety of fuels had been employed, viz., gas coke, oven coke, or anthracite, but almost entirely gas coke from local sources. At Elland all the malt is screened and brushed in a Barron's machine before leaving the malting. At Brighouse the malt is hand-screened only and not brushed. All malt is brushed besides at the brewery in a Nalder's machine, which has been in use for eleven years.*

I ascertained from the Elland maltster's books that the last of the 1900-1 season's malt was sent to the brewery on the 26th November, 1901; the first of the new malt was sent on November 4th. I ascertained also from the brewer's books at the brewery that all last season's malt was finished by December 5th, and this tends to support the brewer's statement that both the brews under enquiry (one or other of which, according to Mr. Allen, gave beer containing 1-24th of a grain of arsenic per gallon) had been prepared with new malt. It may, however, be noted that although beer from Messrs. Ramsden's brewery was being consumed by three of the infirmary cases, Nos. 1, 7, and 8, up to January, 1902, these men in each instance were getting beer from other suspected sources as well, and thus there is not any strong evidence that harm resulted from Messrs. Ramsden's December beer. But there is more definite evidence suggesting that other and earlier beer from this brewery produced illness in the circumstances of case No. 4 (Nancy Wilkinson). This woman, whose illness had become established by October 8th, 1901, when she was admitted into the infirmary, had obtained all her beer from the "Black Horse" at Brighouse, supplied by Messrs. Ramsden. As Messrs. Ramsden did not begin to use this season's malt till after November 4th, the beer that she drank would have been brewed from last season's malt, made almost wholly over gas coke. At Messrs. Ramsden's I was shown several reports that malt (and other brewing ingredients and beers) had been analysed and found free from arsenic. These reports were principally by the borough analyst of Halifax, Mr. Ackroyd; one by Mr. Lawrence Briant, which related to Brighouse malt of the 10th January, 1901, stated that it contained a small but negligible trace of arsenic. This particular sample Messrs. Ramsden inform me had been made over gas coke.

The Yorkshire Brewery Company.—The particular beer here enquired about (that in which Mr. Allen found 1-16th of a grain per gallon) was at first stated by Mr. Badley, the company's brewer, to be one of two brews between December 9th and December 15th, 1901, either brew No. 209 or No. 211; but in a letter dated February 16th he mentions four brews as "implicated," viz., Nos. 201, 211, 216, and 219, and does not mention 209. According to this letter all the brews contained 15 quarters of old Yorkshire malt (*i.e.*, of malting season 1900-1) to 5 quarters of new malt.

I may note that at the time of my visit casks of beer from the above brews were still in use; Mr. Dawson, the Company's chemist, had procured samples of these brews and had sent them to Mr. Fairley, their consulting chemist, and Public Analyst of Leeds—I have not heard with what results. I may mention, however, that Dr. Cameron, Medical Officer of Health for Leeds, has lately obtained samples of beer from public houses belonging to this brewery in Leeds, and Mr. Fairley has in two, which do not appear to have been taken with the formalities prescribed by the Sale of Food and Drugs Acts, reported 1/40th of a grain of arsenic per gallon. Since Mr. Allen's statement at the inquest, and before my visit to the Yorkshire Brewery Company, Mr. Fairley had, however, examined 27 brewings of this brewery and found them all free from arsenic, except one, a strong beer, brewed on January 16th 1902, in which he found under 1/100th of a grain per gallon.

At the Yorkshire Brewery Company they make their own malt. This season they have used a mixture of anthracite and oven coke, principally the latter, on account of the construction of their fire-pans. Last season, up to February, 1901, they were using gas coke alone, and I was assured that the 15 quarters of old Yorkshire malt in the above brews would have been made comparatively early, and almost certainly over gas coke from Rothwell. The invoice corresponding to the first delivery of anthracite at their malting was dated February 18th, 1901.

Messrs. Whitaker's.—Visited January 24th and January 29th, 1902. The beer from this brewery was not one of those which came under suspicion as a result of chemical analysis, but two of the infirmary patients, cases 7 and 8, had got their beer partly from this brewery, and one case, No. 3, almost wholly. Accordingly, I enquired as to beer from this brewery which was on sale about the end of December, 1901. I was informed that last season's 1900-1 malt was in use up to December 21st, 1901. From the brewer's books I ascertained that beer brewed on the 18th December, 1901, contained 15 quarters of last season's malt to 3 quarters of new malt. Case No. 3 was admitted to the infirmary on the 10th January, 1901, so that presumably the beer which he had been drinking would have been made principally with this old malt. At this brewery they make their

* The possibility that an old brushing machine might contaminate malt if for many previous years it had been used to brush arsenical malt may perhaps be worth inquiry.

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own malt over anthracite and Halifax gas-coke. They use a three-floor kiln with a fan, and claim that as they dry their malt on the upper floor and finish on the lower floor, the malt being dry when it comes in contact with the furnace fumes on the lower floors is not so likely to become arsenical as it would if it were wet. They have made no difference, I was informed, in their fuel this season as compared with last. On inquiry I ascertained that the percentage of anthracite used this season and last was no more than 15. All malt is brushed as soon as it has been made in a Boby's machine, and is now again brushed and polished before being used in brewing.

The above four breweries make their own malt entirely, with the exception of porter malts, which they buy either from Messrs. Plunkett, of Dublin, or Messrs. Warmsley, of London. At the two remaining breweries the malt is bought.

"*Cross Keys.*"—Visited January 17th, 1902. This is a public-house with a small brewery attached, kept by Mr. Swift. The brews which I enquired into here were those in which Mr. Richardson found respectively 1-16th of a grain and 1-35th of a grain of arsenic per gallon. Mr. Swift bought his malt crushed, and ready for the mash tun, from Messrs. Firth and Blackburn, of Cleckheaton, and Messrs. Broadbent, of Bingley. Now he obtains his malt from a third maltster. The brew in which 1-16th of a grain per gallon was found was prepared solely from Messrs. Firth and Blackburn's malt delivered at the brewery on December 5th, 1901. Mr. Swift uses no glucose or invert, but only malt and a small quantity of flaked maize. Messrs. Firth and Blackburn, whose maltings I visited on February 14th, were formerly maltsters on a large scale, but have now sold their biggest malting and only retain a small one. This season they commenced to malt in December, and before that month they had sent out to "Cross Keys" and elsewhere only their old malt of last season. Up to this season they have always used gas-coke from Lowmoor for malting. Since last December they have been using oven-coke. Their malt is screened, but not brushed; it is not brushed by Mr. Swift. In April, 1901, Messrs. Firth and Blackburn had a consignment of malt returned to them by some Lancashire brewer as being too arsenical to be used.* On April 15th, 1901, they sent a sample of malt to Mr. Fairley, who reported 1-30 grain arsenic per lb. Mr. Firth informed me that they have not sent any sample of malt to be tested since. Mr. Swift had never caused any malt which he purchased to be analysed. The brew in which Mr. Richardson found 1-35th of a grain was prepared, according to Mr. Swift, with a mixture of malt from Messrs. Firth and Blackburn, and from Messrs. Broadbent, of Bingley. At Messrs. Broadbent's maltings, I was informed that any malt supplied to the "Cross Keys," and used there in December, would have been made this season. Last season the firm had failed and all malt on the premises was sold by the solicitors for the benefit of the creditors. The maltings had been started afresh in December, 1901; the first fuel used in September was gas-coke, but subsequently oven-coke has been substituted. Messrs. Broadbent's malt is screened but is not brushed.

Messrs. Alderson.—Visited January 29th, 1902. Beer from this brewery was not of those which came under suspicion as a result of chemical analysis, but one of the cases, No. 5, obtained her beer wholly from the "Victoria and Albert," a public-house supplied by this firm. As the onset of illness in this case appears to have been in October, the beer in question would probably have been brewed in August or September of last year, or before. Such beer, I was informed, would have been brewed with old malt of the season 1900-1. Messrs. Alderson in 1901 used to buy malt from Messrs. Worsick, of Northowram, who also have a malting at Elland. Early portion of their 1900-1 season's malt was, I was informed, made from "gas-coke and a little anthracite": the later portion over anthracite. Messrs. Worsick's Northowram malt was being used at Messrs. Alderson's about last August. Their Northowram malt is generally despatched to their Elland maltings, and there screened and brushed before sale, but I learned at Elland that last summer the malt sent to Messrs. Alderson was frequently despatched direct from the Northowram malting, in which case it would be unbrushed. Messrs. Alderson also got last season up to the end of May, 1901, some malt from Mr. Ben Stead, of Brighouse, and informed me that they had it tested, and found it arsenical, and consequently gave up using it. The malt at Mr. Ben Stead's was made over gas-coke. There is no brushing machinery. Whether or no Mr. Ben Stead's malt was being used by Messrs. Alderson in the summer or autumn of last year in brewing the particular beer enquired into, I am unable to say. Mr. Alderson informed me that the greater part of the malt which they were using in September was obtained from Messrs. Worsick.

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Proportions of malt used in implicated brews.

In considering the probability that the beers enquired into became contaminated with arsenic by the use of arsenical malt, the following points are worthy of note:—

The proportion of malt used in the several brews was approximately as follows:—

Brew inquired into at—			
Messrs. Webster's	1·35	lbs. per gal. of finished beer.	
Messrs. Ramsden's	1·4	,,	,,
The Yorkshire Brewery Co.	1·5	,,	,,
Messrs. Whitaker's	1·1	,,	,,
The Cross Keys	2·0	,,	,,
Messrs. Alderson's	1·4	,,	,,

Evidence that beer obtained its arsenic through malt.

If it be taken for purposes of calculation that the beers associated with the Halifax cases were contaminated with arsenic to the extent of 1-16th grain per gallon, and that 1·4lbs. of malt went to the gallon of finished beer, then, if all the arsenic in the malt got into the beer, the malt must have contained about 1-22nd grain of arsenic per lb.

It will be remembered that Mr. Hooper of the Government Laboratory, informed the Commission in May last that he had met with 22 samples of malt in which the amount of arsenic lay between 1-50th and 1-20th grain per lb. and that proportions of arsenic in malt, such as 1-20th grain per lb. have been referred to by other witnesses.

It is known, however, that some of the arsenic introduced into the mash-tun is removed by yeast in the process of brewing, or otherwise does not reach the finished beer.

Again, it will have been noted that some of the malts in question were brushed before use, and the Commission has had evidence that brushing, especially if several times repeated, may diminish the quantity of arsenic in malt very materially. Here I would note, however, that I met with no instances in which attempt had been made to ascertain chemically the extent to which arsenic in a given malt was reduced by one or more brushings in the machine, with a view to discovering and adopting the method of brushing most efficacious in removing arsenic.

Reverting now to the above calculation, and making the (purely arbitrary) assumption that, by reason of brushing and of brewing, only half the arsenic present in the malt reached the finished beer, the malt would originally have contained, not 1-22nd grain but 1-11th grain of arsenic per lb.

Dr. Campbell Brown (Q. 6709) informed the Commission in May last that he had found certain malts which contained respectively 1-9th, 1-7th, 1-6th, and ¼ grain of arsenic per lb. Mr. Estcourt (Q. 3982) mentioned an instance of malt containing up to ½th grain per lb. Mr. Wm. Thomson, I understand, has prepared evidence for the Commission to the effect that in a few malts which he examined between July and December, 1901, he has found arsenic in amounts from 1-30th up to 1-10th grain per lb.—and it would seem from his précis that all these malts came from Yorkshire, a county which has been specially mentioned by witnesses to the Commission in connection with arsenical malt.

These considerations, I think, suffice to show that the suggestion that the beers enquired into became contaminated to the extent indicated through use of arsenical malt cannot be dismissed as *primâ facie* improbable.

Malt seldom tested for arsenic.

For proof to be afforded, it would of course be necessary to know the amount of arsenic present in the implicated malt in each instance. This, unfortunately,

* This was what Dr. Neech and I understood Mr. Firth to tell us on February 14th. At a later visit, however, Mr. Firth informed me that no malt was *returned* to him by the Lancashire brewer, but that the latter, who furnished no particulars regarding the amount of arsenic found, cancelled the contract—a proceeding to which Mr. Firth appears to have made no objection

is at this stage impossible. It is true that since June, 1901, at all the breweries except the Cross Keys publican-brewery, a few samples of malt were occasionally analysed and were stated by the analyst not to be arsenical, or else to contain a negligible quantity of arsenic. But I have no evidence that the particular malts used in the implicated brews were among these samples in any case; and I note that at certain breweries the chemist to whom the malt samples were submitted, Mr. Ackroyd, Borough Analyst of Halifax, was using the form of Reinsch test first recommended by the Brewers' Expert Committee, not the more stringent method which they have subsequently put forward.

The malts which entered into the brews inquired into of course could not be recovered at the date of my visit.* Moreover (with the doubtful exception of Messrs. Ramsden, page 19), they all had been malts of the 1900-1 season, whereas, usually, the malts in use at the dates of my visit were malts of the present season. At Messrs. Webster's, Whitaker's, and the Yorkshire Brewery Company's breweries, I was supplied by the brewer with samples of malt stated to be of last season, and these I have placed at the disposal of Professor Thorpe. Looking, however, to the large output of these breweries, and the quantities of malt used, and to the improbability that at any one of them arsenic would have been present in last season's malt in uniform proportions, it would seem that results of these analyses cannot be expected of themselves to settle the question of the derivation from malt of arsenic in the particular beers enquired into.

It appears, moreover, that there is substantial reason for drawing a sharp distinction between the malts used in the brews under enquiry and malts now in use.

In each instance there is evidence affording a more or less strong presumption that the fuel used to prepare the implicated malts was local gas coke, whereas in later malts (and particularly all those of this season, save at Messrs. Whitaker's) no gas coke had been used.

For example, in the case of the "Cross Keys" publican-brewery, where it was more easy to trace the malt, there appears to be no doubt that the brew in which Mr. Richardson found 1-16th grain of arsenic per gallon was made from malt delivered at the "Cross Keys" on December 5th, and that this malt (unbrushed before using) was made by Messrs. Firth and Blackburn last season, and over Lowmoor gas coke. I have already noted that I ascertained from Mr. Firth that in April, 1901, his malt was considered by a Lancashire brewer too arsenical for use.

At all the breweries visited I found that most of last season's malt was being used up at the end of last year, and this fact, together with the difference in the fuel used, tends to explain the comparative freedom from notable amounts of arsenic of samples of recently brewed beer in Halifax, which appears to be indicated by the analyses of Messrs. Richardson and Allen, given on p. 17.

The advice given by the Commission in their first report that fuel used in the kiln should be carefully selected on account of freedom from arsenic has thus, as regards this season, and in a sense, been adopted at nearly all the maltings which supplied the malts to the breweries in question. Except at Messrs. Whitaker's anthracite or oven coke, or both these fuels, have been substituted for gas coke, the liability of which (and particularly some Yorkshire gas coke) to contaminate malt has come to be generally recognised. In each instance, however, it appeared to me that the maltster was content with the fact that he had changed his fuel, and with the vendor's statement that the new supply was "free from arsenic." Hardly any steps seemed to have been taken at any malting to ascertain what amount of arsenic the new fuel contained, or to what extent its use could be relied upon to ensure safety as regards arsenic in the malt. I may note that at one maltster's I observed several lumps of pyrites of large size in the heaps of anthracite ready for the kiln.

I visited one malting, at Brighouse, where gas coke alone was being used as fuel in the kiln on January 30th. The maltster informed me that the whole of the malt thus made was used at his brewery in Bradford.

* An exception may, perhaps, be made in the case of Messrs. Webster, who gave me a small sample tin, which they informed me contained black and white malt made on 1st February 1901, which (along with other malt) had entered into the brew specially enquired into. This sample was sent to Professor Thorpe.

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8628*. You visited Halifax on behalf of the Commission on January 15th, and subsequently, and inquired there about the cases mentioned in this report?—Yes.

8629. These cases came to light in the Halifax workhouse infirmary, and public attention was called to them by inquests on two which were fatal—McNulty and Lee?—Yes.

Cases elsewhere than in Halifax Infirmary.

8630. We understand that the Medical Officer of Health of Halifax suspects other cases to be due to arsenical poisoning, besides the eight which you deal with?—Yes. I know that he has three other cases which are not dealt with in my report at all, each of which is supposed to be arsenical.

8631. Do you know any particulars of those three cases?—No, I have no particulars of them. Dr. Neech draws attention to them in his report. We have now a formal report from Dr. Neech.

8632. That has just come in, and will be before us?—Yes.

Additional suspected cases in infirmary.

8633. Have there been any more cases in the infirmary besides those dealt with in your report?—There have been three suspected cases that I have not seen. In one of them the man died very suddenly from heart failure after being admitted, and Dr. Hodgson suspected that might be a case of arsenical poisoning. Then, he tells me, there are two other cases in which the symptoms are not very marked.

8634. We understand from your study of the cases you deal with, and from the observations of Dr. Hodgson and others, which you give in the report, that you are of opinion that they are attributable to arsenical poisoning?—Yes.

Dr. Woodyatt's opinion on cause of outbreak.

8635. Does any medical man who has seen these cases doubt that they are arsenical?—No, I do not think anybody doubts it. There was a difference of opinion at first. Dr. Woodyatt at first said that he did not think they were, but afterwards he said he did; but nobody, so far as I know, is of opinion that they are not arsenical; in fact, there is a letter that I should like to read to the Commission which Dr. Woodyatt wrote to the "Halifax Evening Courier" on March 10th, 1902. On the 8th March there had been a short report in the "Halifax Evening Courier" of Dr. Reynolds' examination before the Commission the other day, in which it was mentioned that Dr. Reynolds visited these cases at Halifax at the request of Dr. Hodgson. On the 10th March Dr. Woodyatt writes to the same paper to this effect:—

"To the Editor of the 'Halifax Courier.'

"Sir,—As principal Medical Officer to the Halifax Union Poor Law Hospital, I think it is my duty to correct a false impression which seems to have gained credence with regard to the arsenical cases at the hospital. It will, perhaps, come as a surprise to many when I tell you that I was the first to detect these cases at our new hospital. Why Dr. Reynolds, in his evidence before the Commission, says he is not aware whether these cases had been detected by any other medical men than Mr. Hodgson, is best known to himself. I may tell you, sir, that I wrote to Dr. Reynolds months ago and told him of these cases. I am sure he got my letter, because I have a reply to it in my possession.

Now, sir, I do not wish to take any credit to myself for detecting these cases, for, as Dr. Reynolds says, they were well marked and ought not to be missed by anyone, but there is one gentleman who, I think, ought to come in for a little kudos, and that is Dr. Dolan. He was the first to detect arsenical cases in Halifax at the old workhouse infirmary more than twelve months ago.

"Believe me, sir, yours truly,

"J. F. Woodyatt.

'21, King Cross Road, Halifax,
"March 10th, 1902."

I think I should be right in saying that neither Dr. Woodyatt nor other medical men who have studied these cases have said that they were not arsenical.

1-16th to 1-30th grain arsenic per gallon in certain beers.

8636. You could not ascertain that any of these cases have been taking arsenic medicinally or had been exposed to arsenic by reason of their work?—No, none of them. I made inquiry, and I got Dr. Hodgson to inquire as well.

8637. You ascertained, however, that in some cases beer from public-houses which they had frequented had been analysed in January, and amounts of arsenic from

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one-sixteenth to one-thirtieth of a grain per gallon had been determined?—Yes, that is so. You will find that on page 18 of my report.

8638. You took steps to ascertain the source from which these cases severally obtained their beer?—Yes, I took a great deal of trouble over that. I asked the patients myself, and I got Dr. Hodgson to ask them, and I also got the Medical Officer of Health's inspectors to go into the question as well as to where the beer came from.

8639. And you made special inquiries at six breweries respecting the particular beer which was on sale at places which these persons frequented before these cases were admitted to the infirmary?—Quite so, I did. I went into all the particulars I could get at those breweries.

8640. You traced them as far as possible back to the brews, and ascertained the ingredients used?—Yes, in every case where I could do it. In some cases I could get the exact brew, and in other cases I could not; but I got the ingredients used in the brews about the dates in question.

Implicated brew in which no glucose or invert was used.

8641. With regard to glucose, you found that one brewery—the publican brewery—of Crosskeys, used nothing but malt, flaked maize, and hops—no glucose or invert?—Yes, no glucose or invert was used there, nothing but malt, flaked maize, and hops.

8642. All the five other breweries used glucose, but from different manufacturers?—Yes.

8643. And with regard to invert sugar, three brewers only used it in the beers inquired into, and it came from two different manufacturers?—Yes.

8644. You could get no evidence that these glucoses or inverts were contaminated by arsenic, and you show that if arsenic to the extent of one-sixteenth of a grain per gallon was in the beer, and came from glucose or invert, or both, the contamination must have been much more than anything we have heard of apart from Bostock's. As a matter of fact, you could find no reason to suppose that the glucose or invert was arsenical in any case?—That is so.

8645. With regard to the malts, we understand that four of these brewers made their own malt and two bought it?—Yes—two were not malting brewers at all. The other four made their own malt, except black malt.

8646. You give an account of the inquiries you made to ascertain when and where the malts used in the special brews inquired into were made?—Yes. I show that also in the tables.

Evidence implicating gas coke.

8647. Speaking generally, you find that in some of the brews the malt was certainly made over local gas coke, and that there is strong reason to believe that this was the case with all the others?—That is so. With regard to the Crosskeys brewery, for instance, I traced the malt back, and Dr. Neech traced it with me, and we arrived at the same opinion, that it was made from malt that was undoubtedly made over gas coke at a place called Cleckheaton. It was some of the old season's malt, season 1900-1, and it was supplied to this brewery on the 5th December last year. At the same time I found out that this particular maltster had not begun to make any malt at all in the present, 1901-2, season until December, 1901. So that the malt he supplied to the brewery in question on the 5th December must have been some of his old malt left over from last season when he was using gas coke as a fuel. In this particular case, from Mr. Firth at Cleckheaton, I had a great deal of difficulty in getting evidence. He did not like me going there at all.

8648. Is he a brewer?—No, a maltster. Going back to the 5th December malt, he told me that he had a large contract with a Lancashire brewer, and that in April, 1901, this Lancashire brewer sent to him to say that the beer brewed with his malt was very arsenical. The first time I went to Mr. Firth with Dr. Neech, we both came away with the impression that this actual malt had been returned to the maltster, but on a subsequent visit he told me that the actual malt was not returned to him, but that a sample of the same malt that this Lancashire brewer had objected to as being arsenical was sent to the Crosskeys in December. Evidently it was the same malt.

8649. (*Professor Thorpe.*) December of what year?—December last—1901; and that was used to make beer in which Mr. Richardson found 1-16th of a grain of arsenic per gallon.

8650. (*Chairman.*) Were not those who sent to a brewer malt which seemed opened to suspicion very much in fault?—Mr. Firth went somewhat further than that. He told me that on April 15th, 1901, he had sent a sample of the malt to Mr. Fairley, the analyst at Leeds, and he reported 1-30th of a grain of arsenic per lb. in the malt. After that he never had another sample of malt analysed at all.

8651. Whom do you mean by "he"?—Mr. Firth; he is the maltster. He sent these malts out in a crushed state to the Crosskeys. The Crosskeys man is a small publican brewer who never had heard of such a thing as arsenic in malt. He had never had his malt analysed, and he had never had his beer analysed, but Mr. Firth had had the malt analysed, with the result I have said.

8652. And yet he sent it out?—Yes, he sent it out.

8653. (*Professor Thorpe.*) Is that absolutely clear? Is it absolutely proven that the malt so sent out was identical with that which had been certified as being arsenical?—I will answer that in Mr. Firth's own words. On March 11th I went to see him again. The first time I went to him he had given me to understand that the Lancashire Brewery did return the malt to him, but on the second occasion he said they had not actually returned the malt, but a sample of the same malt was sent to Mr. Swift at the Crosskeys on December 5th. I put it to him, "Is the malt that was sent to Mr. Swift at the Crosskeys on December 5th the same malt, or of the same bulk of malt as the malt that was supplied to the Lancashire Brewery?" and he answered, "A sample of the same malt was sent to Mr. Swift at the Crosskeys."

8654. Did you ascertain from Mr. Swift whether he was in the habit of getting his malt from this firm?—He had been in the habit of getting his malt from two firms, from Messrs. Firth and Blackburn, and from Messrs. Broadbent, at Bingley. Messrs. Broadbent, at Bingley, failed about twelve months ago, and all the old malt on their premises was sold by the solicitor for the trustees at Keighley, and they did not commence malting again until 1901, in the month of September, so that they had no old malt on their premises. They only had one little lot of malt done over gas coke at the very commencement of September, and all the rest of their malt in 1901 was done over anthracite. But none of their malt was used by Mr. Swift till later—I think it was on December 25th that Mr. Swift used a mixture of Broadbent's malt with this old malt of Mr. Firth's, and that beer was not found by Mr. Richardson so arsenical as the earlier beer made only with Mr. Firth's malt.

8655. (*Professor Thorpe.*) I am asking this question because, in searching among our Revenue samples which have been sent up to us from time to time by Excise officers, I have discovered a sample of wort from Swift's at the Crosskeys brewed as far back as May, 1901, which I have analysed, and which gives us some idea of the character of the beer that he was turning out at that time. It would appear that the amount of arsenic it contained was not more than that of December 22nd contained; it was substantially the same amount. So far as we can trace the wort of the Crosskeys, as well as of other Halifax brewers, I shall place the results before the Commission in due time.

8656. (*Sir William Church.*) In the evidence which you have put together for us, you say that on April 15th they sent a sample of malt to Mr. Fairley, who reported one-thirtieth of a grain per lb. Then Mr. Firth just after that says that he sent a sample to Mr. Swift, but did he send the bulk? Mr. Swift may have rejected the sample?—I do not know. The same malt was sent to Mr. Swift for brewing with.

8657. A consignment?—Yes, that is what I mean.

8658. But that really is not the bulk?—He sent a bag or two. A little brewer like Swift would not buy much at a time.

8659. He did not send a sample: he sent the malt for brewing?—Yes, quite so.

8660. (*Professor Thorpe.*) He is a publican brewer?—Yes.

8661. (*Chairman.*) You are of opinion that if the malts in the brews inquired into at the several breweries were arsenical to the extent which we know to have occurred in the case of some malts made over gas coke, there will be no difficulty in accounting for the presence of amounts of 1-16th to 1-30th of a grain per gallon of beer made from them?—Yes.

8662. Have you the results of analysis of any of the malts which went into the beers you inquired into?—I do not think I have. I could not get them. At Mr. Firth's both Dr. Neech and I tried to get a sample of the old malt. Dr. Neech showed me a letter from the medical officer of health at Cleckheaton, saying that Mr. Firth had a large bulk of old malt left on his premises. But if this was the case, he must have got rid of it all very quickly, at any rate, we could not get a bit. I had some trouble in getting information from Mr. Firth, but he eventually took me all over the malt kiln. I hunted everywhere for old malt. I went further. He had had at one time two old malting kilns, and one of these he had sold, last autumn I think it was, which was bought by a man named Swyres. I went up to Mr. Swyres' malt kiln, and asked him if he could find me a bit of the old malt. He said, "No, every bit of it has been cleared off," and he could not get me any of the old malt. The same thing happened at Mr. Firth's own malt kiln, I could not get a bit. I particularly wanted it, because I thought it would have been very interesting, to send it to Professor Thorpe.

8663. Was there an exceptionally low stock of malt in Mr. Firth's place when you visited it?—A very small stock. It is a very small kiln that he now works, and there was only just the stock that he was going to sell off this year. He had only begun to malt in December.

8664. He had got rid of all the old malt?—I think he got rid of every bit of it.

8665. Going back to the maltsters you saw as a whole, you found that gas coke malt was in most instances made last season, and that the maltsters are now generally using anthracite or oven coke?—They told me it was the custom last season always to use gas coke. In one or two instances I found there were maltsters who had used a little anthracite last season, but they had used principally gas coke. At Whitaker's, and again at Worsick's, they had used anthracite last year in small quantities; now Mr. Worsick is using anthracite. Where I heard of anthracite being adopted last season, I found out to the month when that anthracite came in. In one case a man proved to me that he did buy some in December, 1901, but, in most cases, it came into use about the middle of the month of February.

8666. Last February?—February, 1901. It occurred to me that that really might explain how we were getting arsenical beer, as it seemed, just at one time last year, and towards the end of the year, notwithstanding the change in fuel. Looking at these maltings I found that except in one instance the maltster when he is making up his store of malt fills a bin from the back wall to the front. For example, his bin is like a very long room, a big place, and when he has made his malt he throws it against the wall, and he gradually fills up to the front of his bin. In some instances the bins are so constructed that when they are getting malt out they can get out the back malt first, but that I saw in rare instances only at malt stores in new breweries. In the old maltsters' bins, such as these that we have been talking about, Mr. Firth's, or at Ramsden's brewery, or Whitaker's brewery, they told me that they would get out last the malt made earlier in the season. Take the months of January, February, March, and April. Supposing you are filling a bin with malt, and have begun to use solely anthracite at the end of February, your February and January malt having been malted over gas coke. At a place like Alderson's brewery, let us say, they go to the maltster regularly throughout the year for supplies; the maltster naturally goes to his bin as required, opens it, and sends the malt which comes first, so that in the months of June and July the brewer may be brewing with malt made over anthracite, but when it comes to August and September he would be brewing with malt that is made over gas coke. If there is anything in that theory at all, and if anthracite is safer to use than gas coke, it would suggest that the beer made during the summer of last year from the outside of the malt heap might be comparatively free from arsenic, being made over anthracite, while the beer brewed in the autumn might be arsenical, having been made with malt made over gas coke. However, there are some few of the bins out of which they could get this malt first.

8667. What you describe involves filling up the bin in the first place, and then emptying it before more is put in?—Yes, and it is then swept out and filled again. I think I ought to say that I asked several of the maltsters if there was anything in that theory at all. They said it had never occurred to them, but they thought it very likely that use of gas coke malt in this way explained those special beers.

8668. Do you think that all the malt made before this time last year is now got rid of, or is there still some of it remaining?—Yes, there is a little remaining in one brewery.

8669. Have they tested it?—That I cannot say. I have very few analyses of malts given me by any of these breweries. They are having them done, but I cannot give them to you.

8670. Have the brewers commenced testing the malts themselves now?—Some of them are sending them to be tested.

Inadequacy of brewers' precautions since Manchester scare subsided.

8671. Can you say what steps were taken by breweries in Halifax before these cases occurred to test their beers and malt for arsenic?—Yes. Some of these brewers had their beers examined very carefully at one time during the Manchester scare; that is, at the beginning of 1901, and then it seemed to them that everything was over, and they did not examine again until lately.

8672. When you say lately, do you mean since the Halifax outbreak?—Perhaps I had better give instances. At Messrs. Webster's the malts were occasionally tested before the present malting season. Since the 14th August they have sent, I was informed, one specimen once a month to Mr. Ackroyd, the Halifax borough analyst, to be tested for arsenic. That is not a specimen of each malting, but one specimen of malt once a month. The beers here used also to be occasionally tested by Mr. Ackroyd, but since the Halifax outbreak the beers have been tested also by Dr. Luff, Mr. Hehner, and Mr. Richardson, and malt has once been tested by Mr. Richardson. Take another brewery, Messrs. Ramsden. I find there that the malt was tested on the 2nd January, 1901, and it was never tested again until the Halifax outbreak.

8673. Was it found free from arsenic in January, 1901?—Yes, it was passed free.

8674. (*Dr. Whitelegge.*) By whom?—By Mr. Lawrence Briant.

8675. (*Dr. Buchanan.*) I think there was a trace?

8675. (*Sir William Church.*) It is stated here in the report, on page 19, at the bottom of the first paragraph, "a small but negligible trace of arsenic." That is one examined by Mr. Lawrence Briant?—Mr. Lawrence Briant tested everything for this brewery.

8676. (*Sir William Hart-Dyke.*) That would be over gas coke?—Yes. I was referring to a certificate of the 2nd January, 1901. These people had three maltings, Elland, Brighouse and Caulder. The Elland malt was passed free from arsenic; the Brighouse malt had "slight, but distinct traces of arsenic," reported as negligible. The beer was analysed on the same date, the 2nd January, 1901, and was passed free from arsenic. Another analysis by Mr. Lawrence Briant on the same date was shown me, and one in which a trace of arsenic was found by Mr. Marshall, of Huddersfield. From that date they never had anything examined until after this recent scare, and then they had their beer examined again on the 3rd February, 1902, and subsequently.

8677. (*Chairman.*) You have stated that the malt in January, 1901, contained a small but negligible trace of arsenic. What is meant by a negligible trace?—That I cannot say; I cannot tell you what this analyst calls negligible.

8678. (*Sir William Hart-Dyke.*) The word, I suppose, is employed to show that there was arsenic there, but not in sufficient quantity to be injurious to health?—Yes, that is the way I should read it.

8679. It was there, but the quantity was so small as not to be injurious?—Yes, the analyst did not consider it injurious: that would be the analyst's opinion. I do not think that you can read the word negligible in any other way. To come to the next brewery, the Yorkshire brewery, since March, 1901, they have employed a chemist of their own. They had an enormous number of beers and malts examined in March, 1901, and they are all passed free, or nearly free, by Mr. Fairley, the public analyst of Leeds. Since March, 1901, they have had their own chemist, as I said, and he is said to test everything, brewing ingredients and everything else. He informed me that he tests every brew, but I have not got any record from him of any examination of malt and ingredients, although he told me that all the beers sent out were tested by him. I have been given copies of a large number of analyses from that brewery.

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8680. (*Sir William Church.*) You say that Mr. Dawson since March, 1901, has tested all the beers of the Yorkshire Brewery Company, and also malts and other materials?—Yes.

8681. But then you go on to say that Dr. Cameron, the Medical Officer of Health for Leeds, has lately obtained samples of beer from public houses belonging to this brewery in Leeds, and in these Mr. Fairley has officially reported 1-40th of a grain of arsenic per gallon. Would that be in the same beers that Mr. Dawson reported as free?—Presumably, yes. If Mr. Dawson has analysed every brew, except a few on the 10th August, when he happened to be taking his holiday—he had ten days' holiday—I do not see that there is any other assumption to be made.

8682. It seems to me an important paragraph, because you then go on to say that since Mr. Allen's statement at the inquest, Mr. Fairley had examined 27 brewings of this brewery, and found them all free from arsenic, except one, a strong beer, as much as to say that the analysts by their own action had been much stricter since the inquest than they had been before?—They sent 27 beers from this brewery to Mr. Fairley, and in one of them, a strong beer, he returned arsenic less than 1-100th of a grain. I saw Dr. Cameron, of Leeds, and asked him what they were doing in Leeds about this question. I said: "How is it that arsenic is only found in Halifax, and not in Leeds?" He sent out and obtained a number of samples, five altogether, from this brewery, but in four of those samples the analyst returned 1-40th of a grain per gallon. The four samples were taken from different houses.

8683. (*Professor Thorpe.*) All Leeds beer?—Yes; some from the same brewery—Yorkshire Brewery Company.

8684. Does "lately" mean before or since Mr. Allen's statement?—Decidedly this is since Mr. Allen's statement, because these beers were collected after my visit to Leeds.

8685. I do not quite understand that. You go on to say that since Mr. Allen's statement at the inquest Mr. Fairley had examined 27 brews, and found them, with one exception, free from arsenic. Was it subsequent to the examination of the 27 that some were found, or one was found with as much as 1-40th?—Yes; I can answer that question decidedly. The same day that I called on Dr. Cameron I called on the Yorkshire Brewery Company, and Dr. Cameron had not collected his beers at the date of my visit to him, while this statement of Mr. Fairley, having seen 27 brewings, was given to me that day at the Yorkshire Brewery, so that these beers taken for Dr. Cameron must have been collected subsequently to those 27.

8686. (*Dr. Whitelegge.*) The 27 were forwarded by the brewery?—Yes.

8687. After the inquest?—Yes.

8688. And after your visit?—No; before my first visit, because they told me of them at the date of my first visit.

8689. At the beginning of the paragraph, you say, "Mr. Dawson, the company's chemist, had procured samples of these brews, and had sent them to Mr. Fairley, their consulting chemist." That was an exceptional course?—Yes.

8690. The usual routine was for him to examine them himself?—Yes; his position there is to examine all the beers or whatever they want examined, for the brewery. He has his small laboratory, and does nothing else; but if they want to check anything they send it to Mr. Fairley.

8691. (*Sir William Church.*) Those 27 brewings, presumably, were taken at different times, between March and the end of the year?—No; I take it otherwise. These 27 brewings were taken after the inquest, and before my visit.

8692. The inquest was at the end of January?—It was on the 17th or 18th January, I think.

8693. So that there really was no check whatever upon the analyses of the beer which was turned out between the appointment of Mr. Dawson, in March, 1901, and the end of the year. They did not send any beers to Mr. Fairley during that time?—I could not positively say no; they might have done.

8694. They might have done, but we have no evidence of any check upon Mr. Dawson's analyses?—No; I have no evidence that they did. Although I have been supplied with quite a large number of analyses from that brewery, there is nothing from Mr. Fairley that comes in between those dates—between the 10th March, 1901, and the date of the inquest.

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(*Professor Thorpe.*) I thought Sir William Church's question was what was done prior to the appointment of Mr. Dawson as a regular chemist?

8695. (*Sir William Church.*) My point is rather this, that Mr. Dawson's appointment may or may not have been a protection to the public, according to the accuracy of his analyses; and we have no evidence either in support of the correctness of his analyses or invalidating his analyses between March 1901 and the inquest. That was my point?—Just so. The next brewery I take is the Crosskeys. They never had anything analysed at all. Then at Alderson's Brewery they showed me several analyses of malts used last year. They had found arsenic in one of their malts, which was sold by a Mr. Ben Stead, of Brighouse. After that arsenic was found, by Mr. Ackroyd, they did not use any more malt from that malting; they left that malting. But since, they have had no malt analysed for six months. They had some beers analysed by Mr. Ackroyd, but I obtained no record of them. But in January, 1902, since this Halifax outbreak, they have had beers passed as free from arsenic both by Mr. Miller and Mr. Ackroyd. I have seen another analysis from Dr. Luff, quite a recent one, which does not quite agree as to freedom from arsenic. Then, as regards the testing which has been done by maltsters who are not brewers, at Messrs. Broadbents I was told casually that their malt was tested a year ago, and said to be free, but they could not show me anything. At Messrs. Firth and Blackburn's, as I have said, the malt was tested on the 16th April, and 1-30th of a grain was found. It has never been tested since. Then I think I ought to put in, in common justice to the maltsters—having said all this about those who have done so little testing—what has been done by Mr. Worsick. He is a maltster who first used anthracite. He sent me a list of analyses by Mr. Miller, in which I see that from the 14th February, 1901, he has had at least two samples of malt tested every month, and they are all passed arsenic-free. This man has been taking a great deal of trouble.

Little or no testing by maltsters for sale in some cases.

8696. (*Sir William Hart-Dyke.*) He uses anthracite exclusively now?—Yes.

8697. And also during the period mentioned?—Yes.

8698. (*Chairman.*) Do you know whether any of the maltsters have had their fuel analysed?—One. Mr. Ben Stead, of Brighouse, told me that he had had his fuel analysed. He sent a sample to Mr. Rimington, who told him it was arsenic-free.

8699. (*Sir William Hart-Dyke.*) Is that gas-coke?—No; anthracite. I asked him to show me the analysis, but he could not do so. He said that he had sent it away to a friend.

8700. (*Dr. Whitelegge.*) Is that the same man who is mentioned in your report?—Yes; the same man as is mentioned in Alderson's Brewery. Aldersons were having malt from him last May; it was examined by Mr. Ackroyd, and reported to contain arsenic, and they discontinued their contract with Mr. Ben Stead in consequence. It was in consequence of that being found that Mr. Ben Stead changed his fuel from gas-coke to anthracite.

8701. (*Chairman.*) With regard to the action of the Halifax authorities, do we understand that the Halifax Medical Officer of Health is about to publish a report?—He has sent me an advanced copy of his report. I asked, when I was at Halifax last time, if it was going to be printed. The Chairman of the Sanitary Committee, whom I saw there—Mr. Coe—informed me that he did not mean to bring the matter before that committee; that he would not have the report printed for publication to his committee or to the public, but that he would have some copies printed only for this Commission. He did not mean to bring the matter before his committee at all.

Halifax Town Council and M.O.H.'s report.

8702. How many samples of beer were sent officially to the Halifax Borough Analyst during 1901?—I looked through the medical officer of health's returns for 1901 and I could not find in those returns that any beer at all had been sent officially to the borough analyst in 1901; but the borough analyst does return one sample of beer as having been examined in the early part of 1901, and he passed it arsenic free.

No sample of beer submitted to Public Analyst during 1901.

8703. (*Dr. Whitelegge.*) That might have been submitted by the consumer?—I think it is very likely that it was supplied by a private consumer.

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8704. Under the Act?—Yes.

8705. (*Chairman.*) He has tested many samples in 1901 for brewers, but seldom found arsenic?—Yes.

8706. In what way did you find that brewers or maltsters were keeping records of any analyses that had been made for them?—They were kept in different ways. At Whitaker's I found them all regularly filed; every analysis was put on a large file. Whitakers had an enormous number of analyses, but they were more for the brewing quality than anything else. They had the beer analysed regularly for its qualities, not for arsenic. They had their malts analysed regularly for moisture and for brewing qualities, but not for arsenic; they only had them occasionally examined for arsenic. All these analyses were kept on a file. In most of the other places the analyses were kept in a drawer wrapped up, with an elastic band round them; they were not kept systematically in books. You would think, in dealing with such an important question, they would have kept a systematic record in books.

8707. It would be very important that they should keep the analyses and bind them together?—I should have thought so.

8708. (*Sir William Hart-Dyke.*) These analyses are no protection as regards arsenic?—Some. For instance, they might send occasional samples to be examined for arsenic, while the ordinary analysis required would simply be analysed for the strength and qualities of beer or its ingredients.

8709. (*Professor Thorpe.*) With reference to the first remark, of course the Commission must bear in mind the system under which the analyst makes a report. The brewing chemist fills up a printed form, and the details are entered into that, and it would be somewhat difficult for the brewers to paste these things in a book. They might keep them on a file, but that is the extent of the ordinary arrangement in which it would be possible to do it?—Perhaps you would like to see the way in which the analyses are sent. Here are some. (*Handed in.*)

8710. (*Sir William Hart-Dyke.*) It seems that there has been a division of opinion amongst the medical men as to the cause of death in these cases. I think you rather impressed upon us the fact that Dr. Woodyatt at first was of opinion that these deaths were not caused by arsenical poisoning?—He said there was a difference of opinion, but that was mainly on the first and fatal case, McNulty.

8711. I see you say in your statement on page 18 that the gentleman who represented the Halifax brewers at the inquest made much of the fact that Dr. Woodyatt stated that the cause of death was not arsenical poisoning?—He said that at the inquest.

8712. Can you tell us how it was that he came round to the other opinion?—The remark in the paragraph you are reading refers to McNulty, the first inquest. At the first inquest Dr. Hodgson said that the case was arsenical poisinong, and at the second inquest Dr. Woodyatt came up and said the cause of death in this case was not arsenical poisoning, it was due to hypostatic pneumonia. But when Lee came into the hospital, he told me that the case of Lee was undoubtedly one of arsenical poisoning, and that if he died he should report it to the coroner. He then showed me some other cases, the case of Marsden, Lowrie, Wilkinson, and Shearing. He agreed that those four cases—and he has written a letter to-day to say so—are arsenical poisoning. Some of these cases were seen by Dr. Reynolds, who has told the Commission his reasons for thinking them to be arsenical poisoning.

8713. The subsequent cases led him to change his opinion as regards the diagnosis of the previous case?—I do not know that it did that.

8714. He gave a very decided opinion that a certain case was not arsenical poisoning?—I do not know that he changed his opinion of the cause of death in the first case.

8715. But he had no doubt as regards subsequent cases?—I did not understand that he had any doubt.

8716. With regard to your statement that there was suspicion that there were certain cases which had not been tested; was there any evidence of that?—I do not quite follow you.

8717. In an earlier statement with regard to those cases you said there were suspicions that there had been other cases of arsenical poisoning in the Halifax Infirmary besides those in your report?—Quite so.

8718. Is there any evidence to warrant this suspicion that there were other cases?—I have none besides what is stated in a letter which I have received from Dr. Hodgson.

Additional cases in Halifax infirmary.

8719. There was a case mentioned of a death from heart failure, but death from heart failure is not an uncommon thing, surely?—In this case all that I know from Dr. Hodgson is that the man when he came in was in a very critical condition. There was keratosis of the skin on the soles of the feet. Dr. Hodgson did not have time to examine the reflexes. There was a scar on the body which was very light in colour with the skin all round.

8720. Was that the case of heart failure?—Yes. He had not time really to examine it, because the man died so rapidly. I do not suppose for a moment that unless he had had the other cases in the hospital he would have had the slightest suspicion of this one, but having the other cases he also suspected this one. He knew that the man was a very heavy beer drinker.

8721. I suppose you saw a great many brewers and maltsters during your visit?—Yes.

8722. How many maltsters did you see, roughly speaking?—Including the brewers—four of the brewers are maltsters.

8723. I am including them?—I saw, I think, twelve maltsters.

Maltsters abandoning gas coke.

8724. My point is this, what is the general result of your conversation with them, and the general evidence which you collected with regard to the use of gas coke? Are you of a decided opinion that the fact of these malts becoming impregnated was due to gas coke? Is that the judgment you have formed?—Yes, and these maltsters have evidently formed the same opinion themselves.

8725. I was coming to that in the next question. In regard to these maltsters, did they seem also to have come to a pretty unanimous conclusion as regards the use of gas coke?—I take it that most of them have come to abandon gas coke as a commercial advantage, or necessity. I found that some brewers ask for malt that is made over anthracite.

8726. (*Chairman.*) Had these brewers been in the habit of asking for it before this scare?—Not before the Manchester scare. In the same way I found that maltsters for sale find it difficult to sell a gas coke malt. Therefore they have taken to anthracite. Mr. Worsick took to it from actual analysis. He was selling malt up in the Manchester district, and he heard of arsenic in malt. He went back and had his malt tested, found it was arsenical, and changed to anthracite as early as December, 1900.

8727. (*Sir William Hart-Dyke.*) Therefore it can be no hardship whatever, as regards the business of a maltster, if to-morrow the use of gas coke were forbidden?—I understand that some of these maltsters would have to alter the structure of their kilns in order to burn anthracite, but they can burn oven coke in their kilns at present.

Brewers demanding malt prepared with anthracite.

8728. But as a matter of business it would be no hardship if the brewers are demanding such malt?—No, as a matter of business the brewers are asking for it. I learned that last July, when I was making some inquiries of maltsters. They told me then that the brewers were asking for it.

8729. (*Professor Thorpe.*) Asking for malt made over anthracite?—Yes.

8730. Exclusively?—Some say anthracite or oven coke, and some say anthracite.

8731. What did you learn—that there was any special preference in favour of anthracite, or that they would take readily malt which had been certified to be made over oven coke?—I heard then that they were asking for anthracite or oven coke.

8732. As an alternative?—Yes, that they did not mind which in some cases; but in the summer I heard that they were asking for anthracite, I heard that in several places.

8733. (*Dr. Whitelegge.*) Were these the Halifax brewers?—No, these were maltsters. I went round and saw a few.

8734. In Halifax?—No, I saw them in different parts of the country.

8735. (*Professor Thorpe.*) With regard to the alternative preference, was that based in your knowledge on the results of analyses? How did they arrive at the

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conclusion that it did not matter whether it was anthracite or oven coke?—I think it was because they had heard of arsenic in the malt, and that the arsenic was attributed mainly to gas coke, and so they got frightened. But I have really no evidence as to their reasons.

8736. The point of my question is this, the brewers did not find it absolutely necessary to demand only and solely anthracite-made malt?—No, I do not think they did, but last summer I only saw a few maltsters, not the brewers they supplied. There is occasionally a lot of this sort of stuff comes out of the anthracite. Here is a piece of pyrites, picked up in one of the furnaces at a malting near Halifax.

Lumps of pyrites amongst anthracite.

8737. (*Chairman.*) Probably there is arsenic in this?—That happened to be a piece that was thrown away because it was a heavy piece. The maltster noticed the weight of it on his shovel, and threw it out. I then went up to the fire pans, and I pulled some of the fire pans about, and I found a piece of it burning in the pan; that is, the fire that is underneath the kiln floor.

8738. (*Dr. Whitelegge.*) What date was that?—The last time I was up there, February 13th.

8739. (*Chairman.*) This lump is vastly greater in specific gravity than anthracite?—Yes; it was so heavy that they noticed it by its weight.

8740. Did not they use sifted anthracite; did they get the anthracite coming in in lumps?—Yes, all round the Halifax district they get it sent up in large lumps. In the summer, I forget whether it was Mr. Taylor or Mr. Earp told me that it was very much better to buy the anthracite hand picked in small pieces. They have it about as big as a tangerine orange. But all over the Halifax district the anthracite comes in large lumps, and some of these lumps that I picked up were so big and heavy that I do not think I could have taken them up in one hand.

Maltsters who continue to use gas coke.

8741. Do not they break it into small pieces themselves?—No. They do break it up, but not very small. Some of the maltsters use nothing but anthracite, but in other places they have used a great deal of oven coke with it. They were using several different fuels at Halifax when I was there. At Messrs. Whitaker's, on the day of my visit, they were using gas coke and anthracite. I said, "How much do you actually burn?" and it came out that they burned 85 per cent. of gas coke and 15 per cent. of anthracite. They were actually using gas coke when I was there.

8742. What date was that?—That was the 15th February, 1902. They said they were going to change to oven coke.

8743. (*Professor Thorpe.*) Did you go to Messrs. Brear and Brown?—Yes, I did.

8744. Did they tell you that at any time they were using Bostock's glucose?—Yes, they gave me the reason for it.

Halifax brewery implicated during 1900 epidemic destroyed their beer.

8745. Why?—They ordinarily went to Garton Hill's. Garton Hill's ran short of their supply of glucose, and asked Brear and Brown as a favour to them to take Messrs. Bostock's glucose, because they were short. They could not go on.

8746. (*Chairman.*) When was that?—This would be during the beer scare of 1900. They found the arsenic in the beer they sent out, and had it destroyed.

8747. (*Professor Thorpe.*) Have you any evidence that they actually had their beer destroyed?—I had it from three sources: first of all I was told they destroyed their beer by Dr. Neech, the Medical Officer of Health; I was told by Mr. Brown that it was destroyed, and in the presence of the Excise officer at Halifax.

8748. Did you ask Mr. Sergeant, the Excise officer at Halifax?—I asked Mr. Sergeant, and my impression on that point is that he told me it was destroyed—a note to that effect is in my notebook.

8749. He saw it?—Yes.

8750. Did you ascertain from Messrs. Brear and Brown what they did to cleanse their vats and apparatus from the arsenical contamination which they had received?—No, I did not.

8751. In the course of your inquiries have you had occasion to see oven coke made?—No, I very much want to. I have never seen it made.

8752. You do not know what process of sifting the coal goes through?—No, I do not.

(*Chairman.*) Why should oven coke be freer from arsenic than gas coke?

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(*Professor Thorpe.*) Because it is specially picked in the first instance from a coal supply, which is as free from sulphur as it is possible to get it. Oven coal is very largely used in iron smelting. It is a necessity that it should be as free as possible from sulphur, and that incidentally helps to make it free from arsenic. It is usually hand picked before it is put into the oven, so that the possibility of a mass of pyrites getting in, such as you saw in the case of this anthracite, is very largely eliminated.

Less arsenic in oven coke than in gas coke, due to hand-picking of coal.

(*Chairman.*) Do you consider that oven coke on the whole is safer than anthracite?

(*Professor Thorpe.*) I am not prepared to say that. I am prepared to say it is a reasonably safe fuel. If due care was exercised in the selection of anthracite to the exclusion of pyrites, anthracite might be probably an excellent fuel; but there is always the danger, as you see, of masses of pyrites getting into the anthracite.

(*Chairman.*) It must be hand-picked anthracite to be safe in the malting oven?

(*Professor Thorpe.*) No doubt.

(*Witness.*) With regard to anthracite, I may mention that when Dr. Neech and I were going round one of these maltings, we went into a malting where they used nothing but anthracite, and Dr. Neech collected some of the dust from the wall of the kiln; that is, dust that was lying over the malt, that was being malted. That dust was given to Mr. Richardson, of Bradford, and he estimated the arsenic in that dust to be as much as one and two-fifths grains per pound.

Arsenic in kiln dust where anthracite used.

8753. (*Chairman.*) That does not appear in your printed report?—No, it was not related to the beers I inquired about. This dust actually being over the malt can fall on the malt, and no doubt does so when the men go in and stir the malt about, as they must disturb that dust which is all round the walls.

Such dust may fall on to malt.

8754. Was that a maltster's kiln?—Yes, this was in the kiln of Mr. Ben Stead, who had used gas coke in the old days, but who is now using anthracite. He has used anthracite ever since last September (1901). He said that before he took to anthracite he had all the floor of his kiln taken out, washed, and relaid, so as to get as much arsenic out as he could, and his kiln was whitewashed down—they whitewash them every summer. After using anthracite all through the winter this result was obtained from the dust.

8755. The dust resulting from the use of anthracite for malting?—Yes.

8756. (*Sir William Hart-Dyke.*) This was from anthracite?—Yes; this came from anthracite. I did not find any bits of pyrites in that kiln.

8757. (*Chairman.*) That suggests the need for very careful hand-picking in the use of anthracite?—Yes.

8758. Had hand-picking been practised in that particular case?—Not by the maltster. I cannot say how much it had been done at the colliery, but it had not been done by the maltster. Hand-picking at maltings merely means throwing out a lump of stuff which a man notices as unusually heavy or brassy, so far as my limited experience goes.

May be little hand-picking of anthracite at maltsters.

8759. What size of lumps were there in this particular malting?—He was using about the size they were all using—as big as this box.

8760. Could hand-picking clear out the dangerous pieces in that case?—I do not know. I really would not like to answer that question. I cannot tell you how small the pyrites might be, but I suppose it would help.

8761. (*Professor Thorpe.*) In the hand-picking, they not only look at the thing, but they take it in the hand. It is so heavy relatively to coal that it at once attracts attention, and if there is any considerable quantity of pyrites in a lump it excites suspicion because of the weight?—No doubt that is so.

8762. (*Dr. Whitelegge.*) You told us that there was a general demand now for anthracite?—Yes; I heard a good deal of that in the summer.

8763. It did not extend particularly, or perhaps at all, to the Halifax region which you have been visiting lately?—No; there I found a great deal of oven coke used.

8764. I think your evidence goes rather further than that—that the maltsters, including some brewers who are their own maltsters, are using gas-coke even now?—Yes; I found that in Whitaker's brewery they are using 85 per cent. of gas-coke now, and 15 per cent. of anthracite. Then, again, I might say something

Maltsters who continue to use gas coke.

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with regard to a malting which I visited at Brighouse, which had no connection with the beers I inquired into. I would like to explain that the men whom I saw at these maltings were the labouring men. These men told me that they always used anthracite at this place. I said, "What are you doing now?" I was on the malting floor, and I could smell the stuff. They said, "We are out of anthracite, so we are using coke." They were doing the malting with gas-coke.

8765. (*Chairman.*) Was it oven coke that the workman meant when he said coke?—No; gas-coke. I went down and saw it. At Messrs. Websters' they changed as far back as February, 1901, from gas-coke to anthracite. I saw a lot of analyses of their malts the other day when I was up there, and curiously enough, some of the latest-made malts showed more arsenic than usual. I asked them what they had been doing, because I had a paper from Dr. Neech, giving me the sales of gas-coke from the Halifax Corporation Gas Works, which showed that Messrs. Websters had had a sale of coke made to them last December, that is December, 1901. I said to them, "You have been using gas-coke again." The brewer laughed, and said, "Yes, we were out of anthracite last December, and we did use some gas-coke." So that, after having taken the trouble to clean his kiln and use anthracite, he had run the risk of fouling his kilns again with gas-coke.

8766. Was any examination made of the dust in that kiln?—I did not get any of the dust there.

8767. (*Dr. Whitelegge.*) So that in this particular region there has been carelessness even up to the present date on the part of some of the maltsters in regard to the use of fuel?—Yes, I suppose it would be carelessness.

8768. They continue to use gas-coke?—Quite so.

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8769. When they use anthracite, is it usual to require any sort of assurance as to freedom from arsenic?—They showed me a great number of guarantees that the anthracite was free from arsenic.

8770. Does that take the form of affirming that the fuel is free from arsenic, or that it is hand-picked?—They use the actual phrase, "This fuel is free from arsenic."

8771. In the particular case where you found the lumps of pyrites, was there any such assurance given by the vendors?—Yes, I saw it.

8772. The lump of pyrites which you have was from coal guaranteed free from arsenic?—Yes.

8773. Was that in writing?—It is printed on the head of the invoice. I have also seen a large number of letters from colliery owners and colliery agents, saying that the coal they sold had been analysed, and was found free from arsenic.

8774. That is a general statement?—Yes.

8775. I understand you that on the invoice of the consignment it says that the consignment is free from arsenic?—Yes, "this coal," I do not like to use the word this *consignment*, "this coal is free from arsenic."

(*Professor Thorpe.*) You understand it does not mean "this consignment"?

8776. (*Dr. Whitelegge.*) I want to know what they actually said on the certificate going with the coal?—It is generally in the form of a general guarantee.

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8777. It amounts to a guarantee, if an assurance of freedom from arsenic is attached to a particular consignment. I did not raise the point whether that particular consignment has been analysed. Does the assurance come on each invoice?—In some of these places they will send a general guarantee, and in some they guarantee each invoice.

8778. (*Professor Thorpe.*) One is a special guarantee and the other is a general guarantee.

8779. (*Dr. Whitelegge.*) Then it does not always appear on the invoice?—No.

8780. In such cases it is given at the time the contract is made?—Yes.

8781. You mentioned in your report that where glucose was used, "Except at Messrs. Alderson's, I saw the invoices, which in each instance guaranteed the products to the brewer as free from arsenic." Were those printed?—Yes. It is printed or stamped across the bottom of the invoice.

8782. Did you gather that that was in consequence of a request from the purchaser, or that it was done as a matter of routine?—It appeared to be done as a matter of routine.

Mr. H. H. Smith. — 21 Mar. 1902.

8783. Harking back to the anthracite, did you gather that the certificate, whether general or particular, was given at the request of the purchaser, or as a routine?—Routine, I think, entirely.

8784. Take the condition of matters in the Halifax breweries let us say on December 31st last: There had been some cases of arsenical poisoning at Halifax at the time of the earlier epidemic, had there not?—Yes; I believe there were a few—I forget how many—about the end of 1900.

8785. The attention of the Halifax brewers had been directed to arsenic then, and public attention had been drawn to it as well?—Yes.

8786. What new precautions were they using at that time? I gather from what you told us that they had at one time made some analyses, but that generally the precaution of analysing for arsenic had been given up?—Yes.

8787. It was kept on in a few instances only?—Yes.

8788. One firm, you tell us, had appointed a chemist?—Yes.

8789. Other firms, I presume, had not?—Yes, that was the only firm.

8790. And apparently some samples escaped that chemist's vigilance, which were found elsewhere to contain a material proportion of arsenic?—Yes.

8791. So that the analyses of either finished beer or wort, or of glucose or invert, were not receiving that attention which we were led to expect by what was done by the brewers in Manchester?—I should say in most of the cases it was not. Some of the brewers, as I told you, have done nothing at all between the beginning of 1901 and January, 1902.

8792. Although some of them were using anthracite, others, you told us, were still using gas coke, and a number were using oven coke. The assurance of freedom from arsenic that they received in the case of the anthracite was not given at their own request, but as a matter of routine?—Yes, I am afraid it is a matter of routine.

8793. And the same applies to the glucose?—Yes.

8794. That is also routine?—Yes. I may mention that I happened to come across a member of a firm which I have mentioned here, Messrs. Thompson, of London—in fact, it was Mr. Thompson himself. I asked him what the value of the guarantee across this invoice of glucose was worth. I said, "You are a merchant, how is this done?" It works out in this way, that they guarantee all American glucose. When the American glucose comes over to England it is guaranteed free. The merchant does not have it analysed, but he guarantees it on that guarantee to the broker; the broker does not have it analysed, but he guarantees it on the merchant's guarantee to the consumer. So that they guarantee a thing of which they have no personal knowledge whatever.

Guarantees with glucose, given by middlemen.

8795. The malt is usually brushed?—Yes.

8796. But frequently it is not brushed?—I do not think the smaller brewers or maltsters brush it at all.

8797. Is any guarantee asked for by the purchasers of malt, that it has been brushed?—No, I never heard of it.

8798. I am speaking now of your recent investigations?—I never heard of it.

8799. There are no precautions taken in that direction either?—No.

8800. Did you find among the brewers and maltsters whom you saw any recognition of their own default in these matters?—I think they were very much upset; some of them, of course, were exceedingly upset because this disturbed their trade. They said they thought they had been doing everything, and that they were safe.

Attitude of Halifax brewers; extent of their precautions against arsenic.

8801. Did they admit default on their own part?—No.

8802. It did not occur to them that they had fallen short of what had been expected of them?—No.

8803. Do the brewers still deny that these cases were arsenical poisoning?—I do not think they do now. Some of them say it is all rubbish; that is perhaps the general impression about it.

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8804. You did not hear from them any expression of regret for anything they had left undone in the matter of reasonable precautions in the past?—No, I did not.

8805. With regard to the epidemic, let us take the contrast between the conditions last year before the recent Halifax epidemic and the conditions now. Gas coke is still continued in use by some of the maltsters?—At the Brighouse malting I spoke of, yes. At my last visit to Whitaker's brewery they were still using gas coke, although they intended to change.

8806. (*Chairman.*) Do they have their malt analysed before they send it out for sale?—No.

8807. They do not have it tested for arsenic?—No. Whitaker's were using gas coke, and they only very occasionally had a sample tested. They did not sell their malt, they used it in their own brewery. At the Brighouse malting, where I saw them using gas coke, they were going to use it in their own brewery at Leeds. I think I may give a second-hand piece of evidence here. Dr. Kay told me that at Selby there was a man using gas coke and selling his malt regularly, and he said he was not going to change from gas coke for anybody; he liked gas coke best, and he was going to continue to use it.

8808. (*Dr. Whitelegge.*) There has been no analysis in that case?—I understand not.

8809. To go back to precautions taken since this Halifax outbreak, is all the malt brushed now?—No; the malt that comes out from the small maltsters receives no brushing. It is hand screened.

8810. (*Chairman.*) It goes into the beer without being brushed?—Yes.

8811. (*Dr. Whitelegge.*) Have any additional brewers in that region begun to employ chemists of their own?—No, I was asked a question by several of them whether it would not be a wise thing to do so, and I always answered them in the affirmative. I am under the impression that one firm, Messrs. Websters, are going to put up a laboratory and employ their own chemist.

8812. There has been a considerable increase in the amount of analyses of beer?—Yes, very great.

8813. Can that be said of malt?—I have not obtained nearly so many analyses of malt as of beer.

8814. So that you would say now that the brewers are frequently examining their beer for arsenic?—Yes.

8815. But you cannot tell us that they are also carefully examining the malt?—No, I cannot. I have a table here which shows the different things that have been examined so far as I could ascertain. I find at Websters' brewery the beers have been analysed a great deal, but they have comparatively few analyses of malt. At Ramsden's they did not seem to find much arsenic, but they found some.

8816. They found arsenic in what?—In the malt. The Yorkshire Brewery Company sent me an enormous number of analyses, but I have obtained very few analyses of malt even from them.

8817. So that the examination of malt is not general now even after a second epidemic?—No.

8818. And even in the district where that epidemic occurred?—I do not think it is. They may have got a good many analyses that I do not know of.

(*Dr. Whitelegge.*) But you are not able to tell us that they are doing that?

(*Professor Thorpe.*) I think you are leading him wrong. It is within my knowledge that the examinations of malt have been very largely done by the brewers; I am speaking of the Halifax district.

(*Dr. Whitelegge.*) Since the epidemic?

(*Professor Thorpe.*) Yes. I think what Mr. Hammond Smith meant to say was that it was not within his knowledge. As the question was put and the answer was given it would imply that it was not being done.

8819. (*Dr. Whitelegge.*) Since the epidemic, but not until then, they began to examine their malt systematically. There is one other point about the old malt of 1900-1901 make, which was made largely with gas coke, even by those firms which bought anthracite afterwards. No precaution appears to have been taken from what you have told us to clear out the old stock, whether it was verified as containing arsenic, or not?—I can answer that very definitely. It went into use; that I know.

Use of 1900-01 malt without testing for arsenic.

8820. (*Professor Thorpe.*) For the manufacture of beer?—Yes.

8821. (*Dr. Whitelegge.*) And if there is any of the old stock remaining still that may be going into use?—It is going into use.

8822. You told us that one brewery, I forget which, used fifteen quarters of old malt in every present brew?—Yes.

8823. That is a malt which may be arsenical?—Yes. In that brewery they have an enormous bin which holds about 4,000 quarters of malt. Of course, they fill up the bin with small maltings of about 40 quarters at a time, perhaps less, and the maltings of the greater part of the 1900-1 season were done with gas coke. I found that the old malt they were using was almost certainly made over gas coke. I put that question very definitely to the brewer.

8824. Was that malt tested for arsenic?—I could get no evidence of that.

8825. It is within your knowledge that they are using it for present brews; but you cannot tell us whether it has been tested for arsenic or not?—No, I cannot tell whether it has been tested.

8826. You have told us of a number of things that the brewers and maltsters have left undone in the past, and some things they are leaving undone now. I want to go on to the public authorities. You ascertained that up to the end of 1901 in the County Borough of Halifax there were no samples of beer taken?—None were taken.

8827. With whom does the administration of the Sale of Food and Drugs Act rest in Halifax—with the Health Committee?—I think it is.

8828. Dr. Neech, the Medical Officer of Health, is the executive officer?—Yes.

8829. Did he give any reasons for not taking samples of the beer?—No, he gave me no reason at all. I do not think the Public Health officers in general have been examining beers much. I looked through the returns at Huddersfield, and for the last twelve months there has not been a beer examined.

8830. So that the sanitary authorities were not doing much?—They were not examining beers.

8831. With regard to the public analyst, you mentioned a number of analyses returned from Mr. Ackroyd. Can you say whether in any given sample of beer he failed to find arsenic which was found by other analysts?—Yes; in the beer from the "Crosskeys"; I think that is the best sample to take.

8832. In the same lot of beer?—It was not what you would call an identical sample. One bottle was sent to him and one bottle sent to Mr. Richardson, but the bottles were not drawn at exactly the same time; they were drawn on consecutive dates, but, according to Dr. Neech's report, they were the same beers.

8833. Did you ascertain what methods Mr. Ackroyd is using?—I did.

8834. Earlier on, at the time of the epidemic, or up to the time of the epidemic, he was using the Brewers' Expert Committee's first test?—Yes.

8835. Since then he has used another?—Yes; he has used one recommended by the Society of Chemical Industry and Public Analysts' Committee.

8836. Have you records of positive results obtained by him with the later methods?—No; I understand that Mr. Ackroyd has found arsenic subsequently, but he has not sent in any reports of arsenic in official samples to my knowledge. I have no records.

8837. The Excise officers have not been taking any particular steps; they had no instructions at the time of the epidemic?—Not at the time I went up; not until after my first visit there.

8838. You refer in your report to some action on the part of the brewers, which I should like to know a little more about. One was their action in disputing the nature of the mischief. Is it within your knowledge personally, or is it only second-hand information, that you say there was some attempted intimidation of the medical men?—Only second-hand information, and what is said in a letter which I will show the Commission. Nothing has come of it, and I am not prepared to say that it is more than gossip.

8839. There is a reference here also to representations made to the Coroner?—Yes.

Mr. H. Smith. 21 Mar. 1902.

8840. How did that come to your knowledge?—There is no difficulty about that whatever; that is not a question of letters. I was sitting in the room and heard the Coroner make the statement. At the end of the inquest the jury were just getting up, and the Coroner called them back, and said, "Gentlemen, I wish you to sit down again; there is something I want to tell you." They sat down. On his left were the brewers and the brewers' representatives. He said to the jury, "I wish it to be known that before this inquest a gentleman called upon me and told me how to conduct my business, and it was one of the brewing interest."

8841. The name did not come out?—Not from the Coroner.

8842. (*Chairman.*) That was said in the Court?—Yes.

8843. (*Professor Thorpe.*) It appears in the newspapers?—Yes.

8844 (*Chairman.*) I see from one of your manuscript tables that ½ of a grain per gallon seems to have been found in the dregs of a cask of beer at the "Crosskeys Brewery?—That beer was collected by Dr. Neech; Dr. Neech mentions the subject in his report here. I should like to read it. He says several of the brewers complained about the different results obtained by different individuals, and he then tries to explain it himself. He says, "There may be some slight difference in the methods adopted for the detection and calculation of arsenic," and so on, and lastly he says, "There may easily be a difference in the number of yeast cells present." He goes on to say that in his opinion the beer drawn from the bottom of the cask was not so free from arsenic as the beer from the top. He got some beer from the bottom of a cask that was brewed on December 16th, 1901, from the same malt that produced the beer that Mr. Richardson said contained one-sixteenth of a grain of arsenic. At the bottom of the cask, well shaken up, Mr. Richardson obtained one-eighth of a grain of arsenic per gallon.

8845. (*Professor Thorpe.*) The turbid beer at the bottom?—Yes.

8846. (*Chairman.*) That is beer that might have been drawn for consumption?—No, it was beer that was left after they had finished drawing.

8847. (*Professor Thorpe*). It was the lees or dregs of the beer that no customer would drink?—No doubt.

(*Professor Thorpe.*) Mr. Hammond Smith gave us a considerable number of samples which he collected. We have also had a considerable number taken by the Excise officers, and I have now prepared a short report on them, which I would read to you, if I may.

(*Chairman.*) Certainly; it should be put on the minutes and printed.

(*Professor Thorpe.*) Yes, I desire it to be printed, if you please; I will hand it in afterwards.

The following is the report handed in by Professor Thorpe:—

Report on the results of the Examination made in the Government Laboratory of Beers, Brewing Materials, &c., received from Halifax and District during January and February 1902.

Handed in by Professor Thorpe.

In consequence of the recent occurrence of alleged arsenical poisoning in Halifax, samples of beer and brewing materials to be tested for the presence of arsenic have been received at this laboratory from the Inland Revenue officers at Halifax, as well as from the offices in Bradford and Dewsbury Excise Districts.

The samples were taken from:—

I.—Brewers.

Messrs. Alderson, Halifax.

Messrs. Brear and Brown, Halifax.

Messrs. Ramsden, Halifax.

Messrs. Swift, Halifax.

Messrs. Webster, Halifax.

Messrs. Whitaker, Halifax.

Messrs. Stocks, Shibden Head, near Halifax.

II.—Publicans.

Mr. J. Bailey, "Black Bull Inn," supplied by Messrs. Ramsden.

Mr. J. Carson, "Crown Inn," supplied by Messrs. Stocks.

Mr. S. Fossard, "Duke of York Inn," supplied by Messrs. Whitaker.

Mr. J. Hanson, "Britannia Inn," supplied by Messrs. Webster.

Mr. E. B. Wilkinson, "Brown Cow Inn," supplied by Messrs. Webster.

Note.—The "Black Bull Inn" is at Brighouse, near Halifax, in Dewsbury Excise District and Messrs. Stocks' Brewery is in Bradford Excise District.

The supervisor of Inland Revenue at Halifax states that he has sent samples from the whole of the Halifax brewers.

One sample of wort and three samples of glucose received from Halifax District in May, 1901, found among the samples which have been preserved since attention was first called to the occurrence of arsenic in beer, have also been analysed for arsenic. These samples represent older material than can now be obtained by sampling at the breweries.

It must be pointed out that, except as regards Messrs Alderson, Brear and Brown, and Stocks, the brewing materials sent by the Revenue officers were not part of those actually used in the brewings sampled.

The total number of samples, including the older samples referred to above, received from the Revenue officers is 51. They comprise:—

Beer	13
Wort	2
Malt	10
Hops	7
Glucose	10
Invert sugar	4
Flaked maize	2
Caramel	2
Caramelised malt extract	1
	51

Halifax outbreak, 1902.

Beers, &c., examined at the Government Laboratory.

Beer and Wort.

Of the fifteen samples of beer and wort, one contained an amount of arsenic estimated at 1-25th of a grain of arsenious oxide per gallon; two were free from arsenic, and the remainder contained amounts varying from 1-30th to 1-100th grain of arsenious oxide per gallon.

Malt.

Ten samples were examined, of which none was free from arsenic. The largest amount of arsenious oxide found in the samples of malt received from Revenue officers was 1-60th grain per lb.

Hops.

Seven samples were examined. One was free from arsenic. The maximum amount of arsenious oxide found in any sample was about 1-100th grain per lb.

Flaked Maize.

Two samples were examined, and both found to be free from arsenic.

Glucose.

Ten samples were examined, of which seven were found to be free from arsenic. The largest amount found was about 1-250th grain of arsenious oxide per lb.

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Invert sugar.

Four samples were examined, of which one was found to be free from arsenic, the rest contained amounts from about 1-200th to 1-1000th grain of arsenious oxide per lb.

Caramel.

Two samples were examined, of which one was free from arsenic; the other contained about 1-1000th grain of arsenious oxide per lb.

Caramelised Malt Extract.

21 Mar. 1

One sample was examined, and found to be free from arsenic.

The annexed Table of the Revenue samples received for examination for arsenic shows, where the information is available, date of brewing, quantities of materials used, gallons of wort produced, and its gravity. The Supervisor is unable to furnish this information in the case of the retail samples, with the exception of that from the "Crown Inn."

SAMPLES of BEER and WORT sent by REVENUE OFFICERS for EXAMINATION for ARSENIC.

Source of Sample.	Date of Brewing.	Materials used in the Brewing.						Bulk gallons Produced.	Original Gravity of Beer or Wort.
		Malt.	Flaked Maize.	Glucose.	Invert Sugar.	Caramel.	Hops.		
Breweries.		Bushels.	lbs.	lbs.	lbs.	lbs.	lbs.		
Alderson and Company	27 Dec. 1901	44	336	336	–	–	50	1,703	1,040°
Brear and Brown	16 Dec. ,,	168	1,008	672	672	–	195	4,904	1,053°
Ramsden and Sons	17 Jan. 1902	228	1,008	1,120	224	–	180	7,223	1,044°
Swift	2 Dec. 1901	17	84	–	–	–	16	408	1,048°
Webster and Sons	24 Dec. ,,	160	1,008	672	672	–	190	5,898	1,045° / 1,039°
Whitaker and Sons	9 Jan. 1902	160	1,344	224	448	90	–	5,961	1,039°
Stocks	19 Feb. ,,	88	–	224	–	–	147	1,518	1,068°
Public Houses.									
"Crown"	30 Oct. 1901	88	–	224	Brewed by Messrs. Stocks. –	–	147	1,466	1,072°
"Duke of York"	Particulars cannot be traced			–	Brewed by Messrs. Whitaker			–	1,037°
"Britannia"				–	,, ,, ,,		Webster	–	1,037°
"Brown Cow"				–	,, ,, ,,		Webster	–	1,035°
"Black Bull"				–	,, ,, ,,		Ramsden	–	1,043°

Note.—None of the above beers was primed.

REVENUE SAMPLES.

The details of the examination of the foregoing samples are as follows:—

Samples from Messrs. Alderson.

One beer, brewed 27th December, 1901: Original gravity, 1,040°; arsenious oxide, 1-100th grain per gallon.

The malt contained 1-160th grain of arsenious oxide per lb. The other materials examined were free from arsenic. The amount of arsenic found in the malt accounts for the presence in the beer of 1-140th grain of arsenious oxide per gallon.

One bottled beer, date of brewing unknown: Original gravity, 1,051°; free from arsenic.

Samples from Brear and Brown.

One beer, brewed 16th December, 1901: Original gravity, 1,053°; arsenious oxide, 1-70th grain per gallon.

The malt used in this brewery contained 1-500th grain of arsenious oxide per lb., and the hops 1-100th grain per lb. The invert sugar was free from arsenic.

No sample of the glucose actually used in this beer could be obtained, but a sample from a consignment subsequently sent by the same maker, and believed to be of identical character with that employed on 16th December, was found to contain 1-700th grain of arsenious oxide per lb.

The quantities of arsenic found in the materials account for about 1-250th grain of arsenious oxide per gallon, on the assumption that all the arsenic present in the materials found its way into the finished beer.

Samples from Messrs. Ramsden.

One beer, brewed 17th January, 1902: Original gravity, 1,044°; arsenious oxide, 1-60th grain per gallon.

The materials sent by the Revenue officers were not the same as those actually used in making this beer.

Malt (English) contained 1-160th grain of arsenious oxide per lb.

Malt (foreign) contained 1-250th grain of arsenious oxide per lb.

Glucose contained 1-500th grain per lb.

Invert sugar contained 1-250th per lb.

The amount of arsenic found in the materials examined, which were stated to be from similar supplies to those used in the above beer, accounts for 1-125th grain of arsenious oxide per gallon of beer.

One beer from the "Black Bull Inn" at Brighouse, a public-house supplied by Messrs. Ramsden: Original gravity, 1,043°; arsenious oxide, 1-40th grain per gallon.

The Excise officer reports that Messrs. Ramsden had in stock, at the time of sampling, no beer identical with that supplied to this particular public-house.

The sample from the brewery was such as would be supplied to the "Black Bull Inn" in the ordinary course of business, and was the oldest common beer in stock.

Samples from G. Swift, of the "Cross Keys."

One beer, brewed 2nd December, 1901: Original gravity, 1,044°; arsenious oxide, 1-25th grain per gallon.

The materials sent by the Excise officer, in connection with the beer brewed at the "Cross Keys," were not those actually used in the sample of beer above referred to.

The malt contained 1-500th grain of arsenious oxide per lb. The hops (both English and foreign were employed) contained about 1-200th grain of arsenious oxide per lb.

The above materials would yield about 1-250th grain of arsenious oxide per gallon on the assumption that all the arsenic present found its way into the beer.

r. 1902. One wort received at the laboratory in May, 1901, was examined and found to contain 1-30th grain per gallon.

Samples from Webster and Sons.

One beer, brewed 24th December, 1901: Original gravity, 1,045°; arsenious oxide, 1-50th grain per gallon.

The materials sent for examination were not those actually used in brewing this beer.

The English malt contained 1-60th grain of arsenious oxide per lb.; the foreign malt 1-200th grain; the hops 1-100th grain; and the saccharum 1-200th grain. The glucose and flaked maize were free from arsenic.

These quantities of arsenic would have accounted for 1-60th grain per gallon, had these materials been used in the beer sampled.

One sample of beer from the "Britannia Inn," a public-house supplied by Messrs. Webster: Original gravity, 1,037°; arsenious oxide, 1-50th grain per gallon.

One sample of beer from the "Brown Cow Inn," also supplied by this firm: Original gravity, 1,035°; arsenious oxide 1-30th grain per gallon.

The dates of brewing of these two samples from retailers cannot be given by the supervisor.

One sample of beer, brewed 10th February, 1902: Original gravity, 1,039°; arsenious oxide, 1-100th grain per gallon.

A duplicate determination gave 1-80th grain per gallon.

Samples from Whitaker and Sons.

One beer, brewed 9th January, 1902: Original gravity, 1,039°; arsenious oxide, 1-60th grain per gallon.

The materials sent were not those actually used in the beer sampled. The malt contained 9-1000th grain of arsenious oxide per lb.; hops, 1-200th grain per lb.; glucose and invert sugar each 1-250th grain per lb.; the flake maize and caramel were free from arsenic, and the caramelised malt extract was also found to be free from arsenic. The quantities found in these materials would have accounted for 1-100th grain of arsenious oxide per gallon had they been used in this beer.

One beer, from the "Duke of York Inn," which is supplied by this firm: Original gravity, 1,037°; arsenious oxide, 1-40 to 1-50th grain per gallon.

The supervisor was unable to supply particulars of the date of brewing of this beer.

Samples from Stocks and Co.

One wort, brewed on 19th February, 1902: Original gravity, 1,068°; arsenious oxide, 1-100th grain per gallon.

The materials sent were those actually used in brewing this beer. The malt was of two kinds, viz., English and foreign, each of which contained 1-300th grain of arsenious oxide per lb. The hops showed 1-500th grain per lb., and the glucose was free from arsenic. These quantities account for about 1-100th grain of arsenious oxide per gallon.

One sample of beer from the "Crown Inn," which is supplied by this firm: Original gravity, 1,072°, free from arsenic.

This sample was brewed on 30th October, 1901.

Samples of Glucose received from Halifax Excise District in 1901.

Three samples which arrived here in May, 1901, and which had been preserved, were examined and found to be free from arsenic. All were from the brewery of Messrs. Whitaker.

Dr. Hammond Smith's Samples. 21 Mar. 1902.

In addition to the foregoing samples from the Revenue officers, we received certain samples from Dr. Hammond Smith, of which the details, as supplied by Dr. Smith, are as follows:—

Samples from Swift, of the "Cross Keys Inn" and Brewery.

One sample of common beer: Original gravity, 1,045°; arsenious oxide, 1-30th grain per gallon.

One sample of best beer: Original gravity, 1,057°; arsenious oxide, 1-50th grain per gallon.

One sample of ground malt (marked No. 1), prepared by Firth and Blackman. This contains 1-200th grain of arsenious oxide per lb. Halifax outbreak, 1902.

One sample of ground malt (marked No. 2), prepared by Broadbent. This contains 1-140th grain of arsenious oxide per lb. Examination of samples at Government Laboratory.

If the malt marked No. 2 had been used in brewing these beers, the amount of arsenic found in it would have accounted for 1-83rd grain and 1-66th grain of arsenious oxide in the common and best beer respectively.

One sample of beer from the "Brewer's Cellar," a public-house supplied with beer from Bentley's Yorkshire Brewery. This sample was marked "No. 1, c. 23." Its original gravity was 1,042°; arsenious oxide, 1-25th-1-30th grain per gallon.

This sample was a portion of that taken by direction of the Coroner, and analysed by Mr. Allen, who found in it 1-16th grain per gallon.

One sample of beer from the "Britannia Inn," a public-house supplied by Messrs. Webster: Original gravity, 1,039°; arsenious oxide, 1-25th to 1-30th grain per gallon.

This sample was taken by direction of the Coroner: Mr. Allen found in it 1-18th grain per gallon.

This sample is marked "No. 2."

One sample of beer, brewed 13th December, 1901, and sent by Messrs. Webster to Dr. Smith. Its original gravity was 1,037·85°; arsenious oxide per gallon, 1-25 to 1-30th grain.

It was marked "No. 5," and was stated by the brewer to Dr. Smith to be part of the same brewing as the sample from the "Britannia" immediately preceding, (marked No. 2).

One sample of beer from the "Black Horse Inn," a public-house supplied by Messrs. Ramsden.

The sample was marked "No. 3," and was taken by direction of the Coroner. Its original gravity was 1,044°; arsenious oxide, 1-30th grain per gallon.

Mr. Allen, who analysed a portion of this sample, reported 1-24th grain per gallon.

Two samples of whole malt from Messrs. Webster's brewery.

(a) Foreign black and white malt, sample marked "No. 2."

It contained 1-60th grain of arsenious oxide per lb.

(b) Old Yorkshire malt from Bin 5; contained 1-250th grain per lb.

Samples of urine from patients in the Halifax Infirmary, sent by Dr. Smith:— Arsenic in urine of Halifax patients.

Three samples of urine from Halifax patients have been examined. Two of them yielded indications of traces of arsenic of about 1-80th and 1-90th grain per gallon respectively. The third was free from arsenic.

TWENTY-FIRST DAY.

AT WESTMINSTER PALACE HOTEL.

Friday, 11*th April* 1902.

PRESENT:

The Right Hon. Lord KELVIN (*Chairman*).
The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Professor THORPE.
Dr. WHITELEGGE.

Dr. BUCHANAN (*Secretary*).

Mr. G. S. Thompson.

11 April 1902.

Mr. G. S. THOMPSON, called; and Examined.

Mr. G. S. Thompson.

11 April 1902.

Halifax outbreak.

Evidence in respect of Whitaker's brewery. Observations on Mr. H. Smith's report.

8848. (*Chairman.*) You are here at the instance of your chairman, Mr. Whitaker, who has not been able to attend personally, to give information in reply to the Commission's request?—That is so.

8849. A copy of the draft of Mr. Hammond Smith's report was sent for Mr. Whitaker's information, and you draw attention to some points in which you tell us that the information was incorrect. With regard to Case 6, the man Whalan, in Dr. Hammond Smith's report, we understand you admit that he obtained beer from the York Inn, owned by Whitaker's Brewery, but dispute that he was a regular customer at the York Inn?—Yes.

8850. On what grounds is that disputed?—The landlord says that he did not know the man intimately. He had only called at the house a few times. He knew the man by sight very well, but not intimately.

3851. You point out a clerical error on page 5 regarding the beer obtained by Case 7, where "Whitaker" and "Webster" should be transposed?—Yes, that is so.

8852. Will that make it correct?—Yes.

8853. It is not disputed that part of the beer obtained by Case 7 was obtained at the Druids, and came from Whitaker's Brewery?—We only know that the man said so. We have no knowledge of the man at all.

8854. As regards Case No. 8, Marsden, you say that the "New Rock" reported as one of the public houses which he frequented is not supplied by Whitaker's brewery?—No, it is not.

8855. On page 6, where Mr. Hammond Smith quotes a return of analyses made by Dr. Neech, you say that the "Fox" is not one of Whitaker's houses?—No; we have no knowledge of it at all. I do not know where the house is, or who it belongs to; it is not one of ours.

8856. It seems that information has been given by Dr. Neech that the "Fox" in quotation marks is a misprint; that it was really Mr. Fox a man, a grocer, who sells Mr. Whitaker's beer?—That may be so.

8857. On the same page you say that Mr. Buckley is not chairman of the Brewers' Association?—I merely call attention to that. I thought perhaps it was a clerical error; that is all.

Formation of a brewers' association in Halifax.

8858. It seems that the Brewers' Association was only just recently formed; it was formed, in fact, in consequence of the arsenic scare in Halifax. Mr. Buckley took the leading part in its formation?—That is so.

8859. You say that the invert sugar used in the brew inquired into by Mr. Hammond Smith came from the Liverpool Saccharine Company, not Valentine and Tod as he understood?—Yes; I may possibly have given Mr. Hammond Smith a wrong name; it may have been my mistake.

8860. But it really was from the Liverpool Saccharine Company?—Yes.

8861. However this may be, you are customers of Valentine and Tod, and use their invert sugar?—Not their invert sugar.

8862. You do not use their invert sugar?—No.

8863. But you are customers for other articles supplied by Valentine and Tod?—Yes.

Construction of Messrs. Whitaker's kiln claimed to safeguard against arsenic.

8864. In this *precis* you say that in your kiln the malt does not come in direct contact with the furnace fumes, which have first to go through a dust chamber. Is this some special contrivance at your kiln, and specially adopted as a safeguard against arsenic?—Yes. If you would like to see a sketch of it, I have one with me. I thought perhaps it might assist you in your investigation.

8865. We would like to see it?—This is it. (*Sketch produced.*)

8866. Has the security which it gives against arsenic been tested in any way?—Yes. We have had an analyst from June, 1901 (*explains sketch*). The fumes of the furnace come up *here*; the heat is drawn through *these* holes into the chamber.

8867. *These* holes represent transverse bars?—No; it is arched over.

8868. How do the fumes go?—The fumes go up and then come in *here*.

8869. The fumes come in through the malt *here*?—Yes. In the first place when the barley is taken off the floor it is put on the top floor, and it is dried.

8870. It is heated by air drawn up from the furnace?—Yes, heated by hot air from below.

8871. What does the fan do?—The fans draw the hot air, and takes all the moisture from the barley.

8872. This fan is really for sucking air out?—Yes. When the barley leaves this floor it goes on to the second floor lower down. When it comes to the second floor it is practically dry. All the moisture has been taken from it. It is on there 24 hours, and then put on to the first floor, and there it is 24 hours, and it is dried off.

8873. On this floor it is heated to a high temperature?—Yes.

8874. What are *these* squares?—They are ventilators for each floor to regulate the temperature, which open out into *these* flues which go to the top of the building.

8875. Then what is the security which this kiln gives against arsenic?—It does not come in direct contact with the furnace fumes until it is dried, and is practically malt.

8876. But do not the furnace fumes go all through up to the top floor where it is green?—No, because each floor has malt on it at the time that the green malt is on the top floor.

8877. But the fumes go through that malt?—Yes, but it is practically hot air when it reaches the top floor. The air is drawn out by means of this fan.

8878. All the arsenic has been taken out of it on the way?—Yes. We maintain that it is impossible for it to get contaminated on the top floor. If there is any contamination at all, of course it would get on in the bottom floor.

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8879. The fumes go, containing all the ingredients unchanged, including what arsenic there may be, through all the floors?—Yes; the hot air will go through all the floors undoubtedly.

8880. Am I correct in calling it green malt?—Yes; it is barley when fully grown; when it is first put on to the kiln to dry we call it green malt.

8881. In that moist condition at the top floor the fumes from the furnace do go through it?—Yes; undoubtedly the hot air reaches it after passing through the hot-air chamber and the two floors of malt.

8882. Has there been any investigation to test whether or not the malt is free from danger of arsenic by this arrangement?—Yes; we have tested it periodically, and we have only had a very slight trace of it after coming off the bottom floor, and that was before it was screened and brushed. When it is taken off the bottom floor it is screened and brushed before it goes into the bin. It is then screened and brushed again before going into the mash tun.

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8883. You have no means of testing differentially this process from your previous process in respect to freedom from arsenic?—We have had this all along. It is not a new idea at all.

8884. It is not a new method then?—No; the kiln was erected about 1896.

8885. (*Sir William Hart-Dyke.*) I should like a little explanation of this. If there be contamination it takes place on the first floor you say?—No, on the top floor. We maintain that if there is any contamination takes place it would take place while the malt is green, in its moist state.

8886. That is on the top floor?—Yes; but before our malt leaves the top floor it is dry; before it reaches the furnace fumes it is practically malt. The ordinary kiln has only one floor.

8887. That is why I am questioning you, because I am aware what the ordinary kiln is. It is only in this certain stage that the contamination, you believe, can take place before it becomes malt on the top floor?—Yes.

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8888. And this brushing takes place, when?—After it leaves the bottom floor.

8889. That is the concluding process?—That is the concluding process. Therefore, if there is any contamination it would come off in the brushing, because it would be practically dust.

8890. Has this brushing process always taken place in your business?—Yes.

8891. (*Chairman.*) Which is the dust chamber referred to?—It is called there "hot air chamber."

8892. The lowest part?—Yes. It is a dust chamber, too.

8893. Does dust settle in that chamber?—Yes.

8894. And it is occasionally swept out?—Yes; we have it cleaned out.

8895. Cleaned out how often?—We have had it cleaned out twice this season—once before we commenced, and again about the latter end of January.

8896. Have you ever analysed the dust swept out from it?—Yes.

8897. Do you find arsenic in the dust swept out from the dust chamber?—Yes.

8898. Large quantities?—No, not large quantities.

8899. Does your special malting kiln owe whatever safety it has to the dust deposited in the dust chamber?—Yes, and by means of the fumes of the fires not coming into direct contact with the floor. They must go through the dust chamber before they reach the floor.

8900. Are there other points on which you question the statements in Mr. Hammond Smith's report?—I do not know of any. I think you have gone through them all.

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8901. Do you wish to give evidence as to the precautions you have taken against arsenic since the Manchester scare and before this Halifax outbreak?—Well, of course, we maintain we have always taken precautions, and since the Manchester scare we have employed an analyst to analyse all the materials and the beer before leaving the brewery. Since the Halifax scare we certainly have taken stronger precautions by using better fuel.

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8902. Better fuel for malting?—Yes.

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8903. (*Sir William Hart-Dyke.*) By better fuel what do you refer to specially?—Better coke.

8904. Do you refer to a better class of fuel or a more carefully analysed and selected fuel?—A better class which has been submitted to analysis.

Oven coke now substituted for gas coke.

8905. But it is the same type of fuel?—Yes.

8906. That being what?—Oven coke.

8907. Not gas coke?—No, oven coke and anthracite.

8908. Were you using anthracite and gas coke before the Halifax calamity took place?—Yes.

8909. (*Chairman.*) Before the Manchester scare you did not habitually have analysis of beer made?—No.

Extent of analyses o beer and malt.

8910. After the Manchester scare and before the Halifax outbreak you had analyses made?—Yes.

8911. How often?—Practically every week.

8912. By whom?—By Mr. Thatcher, of Burton-on-Trent, an analytical chemist.

8913. Had you an analyst in your own employment?—No, we have not.

8914. What reports did you receive from the analyst from whom you requested investigation?—Very good ones always.

8915. Was any arsenic detected in any case?—There have been one or two cases where there have been faint traces.

8916. Was that in the beer or the malt or sugars?—A faint trace in the malt and a faint trace in the beer; none in the sugar or other materials. It is only about two occasions, and so slight that it has been impossible to approximate the quantity.

8917. Since the Halifax outbreak you have had your beer analysed by more than one analyst?—Yes.

8918. Has arsenic in such a quantity as 1-50th or 1-30th of a grain per gallon been found in any sample or sample?—The analysts vary so considerably. There are scarcely two analysts who agree upon that point, and if I have your permission I should not like to really answer that question publicly.

8919. (*Sir William Hart-Dyke.*) Not as to what you discovered by analysis?—No.

8920. When you say the analysts varied, you refer to the test being applied to precisely the same sample by different analysts giving different results?—Yes.

8921. You mean that clearly and distinctly?—Yes. On one occasion we had it analysed by three analysts and they all differed.

8922. With a practically identical sample?—Yes.

8923. Was that a sample of malt, or brewing material, or finished article?—A sample of finished beer.

8924. And you wish the Commission to understand that in the case of one sample of finished beer three different analysts brought three distinct results?—That is so.

8925. You would rather not give the results, you say. You do not wish for trade reasons to give the actual figures?—No.

8926. You could not place a concrete case before the Commission?—No. I should not care to this morning. We came here with the idea that this was really a private sitting, and for trade interests, which is a very serious matter to us, we should not like to divulge anything of that sort. We are quite prepared to give the Commission all the assistance we can.

8927. But you acknowledge this is an important point. Although this is a public inquiry, this is an all important point; that is to say, that there should be one standard of analysis applied to all these cases?—It is a very important point. Certainly we brewers—I believe I am voicing their sentiment—are very dissatisfied with the present system.

8928. Would you go so far as to say from your experience with regard to analyses in general that you put no faith whatever in analyses which produce results so contrary?—It does certainly shake our faith, but I should not like to go as far as that.

8929. It shakes your faith considerably, at all events, when you have results so divergent?—That is so. They all say approximate to such an amount. There is nothing definite.

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8930. (*Chairman.*) You could perhaps give privately for the use of the Commission a statement of the reports that you have had with respect to quantities?—We shall be very glad to give the Commission all the assistance and information we possibly can.

8931. (*Sir William Church.*) You would not object to putting in the analysts' reports without their appearing in the Press? You have said that you have had the same identical beer analysed by three analysts, and that the amount which they say is present is very different?—That is so.

8932. It is very important that we should have that, I think, although we would withhold it from appearing in the Press. Would you mind giving it for the use of the Commission?—Certainly I will give it.

85 per cent. of gas coke used before outbreak.

8933. (*Chairman.*) Your malting fuel, up to lately, was 85 per cent. of Halifax gas coke?—To about the latter part of January.

8934. January, 1902?—Yes, the latter part of January.

8935. Had this gas coke ever been analysed for arsenic?—I believe it has on one occasion.

8936. Have you the report of the analysis?—I really could not answer you that just at present. I am not certain on that point.

8937. But you could perhaps give information to the Commission on that point?—Yes, I have no doubt I shall be able to find it.

Anthracite used guaranteed free from arsenic.

8938. Has the anthracite been analysed?—Yes, and also guaranteed by the proprietor.

8939. And the result of the analysis was what?—That it has been free.

8940. There was no trace of arsenic?—No.

8941. Those who supply it to you guarantee its freedom from arsenic?—Yes.

Brushing off malt

8942. Your malt is brushed before use?—It is brushed twice. It is brushed immediately on leaving the kiln, screened and brushed, and then it is brushed and screened before going through the rolls for mashing purposes. I may say that we have all the latest machinery, Boby's machine, practically new.

8943. For brushing?—Yes, we have taken the precaution to have new brushes put in, so that if there is anything on the outside of the malts it will be taken off by the brushes.

8944. How long is it since you have performed all that brushing?—We have done that regularly.

8945. Before the Manchester scare?—Yes.

8946. And you have not made any change since in your process of brushing?—Only that we have renewed the brushes.

8947. But the same amount of brushing you gave formerly as you give now?—That is so.

8948. Have you ever examined the dust that is brushed off for arsenic?—No; we have not.

8949. Have you any experimental test as to the effect in respect to arsenic of the brushing you have given to the malt?—Where there has been a trace on the bottom floor after the brushing—when it has been ready for the mash tun—there has been no trace present, so that we take it it has been taken off by the brushing.

8950. (*Sir William Church.*) Let me understand you. Have you taken a sample malt, perfect malt, from the bottom floor, and have you found arsenic before brushing?—We found a trace of arsenic in that.

found to remove arsenic.

8951. After brushing have you found traces?—No.

8952. Not a trace?—No.

8953. But you have before?—Yes; we have before brushing.

Arsenic in kiln dust.

8954. With regard to your plan you have adopted of malting, has the deposit in the hot-air chamber ever been examined?—Yes.

8955. What was it found to contain?—The arsenic in that has never been estimated; it is not a large quantity—call it a trace.

8956. Is it always arsenical?—Certainly; it is in the dust in the hot-air chamber.

8957. But has any of what is deposited on the walls of the hot-air chamber been examined?—That is what I am referring to. Most of it is deposited on to the floor, of course.

8958. Has any of the deposit in the ventilating flue from the top chamber ever been examined?—I really could not say that. I do not know whether we have taken it from that part.

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8959. You seem to think that what arsenic might be in the hot air would all be deposited on the green malt at the top?—No; it would not affect the green malt at the top at all. By reason of the hot air being filtered through the two floors, it would not affect the malt on the top floor.

8960. You told us just now you thought it was only the damp malt which was in danger?—Yes; but we maintain by having three floors that danger is obviated—that we are free from that. I should like to impress upon the Commission that point.

8961. But you never have examined any of the deposit from the sides of the ventilating flue to see if there is arsenic there?—Not on the top floor.

8962. It is going on the assumption that all arsenic would be deposited as the temperature cooled before it reached that top floor?—That is so; in the hot-air chamber.

8963. But then it clearly is not deposited all in the hot-air chambers, because we find it in the finished malt of the bottom floor?—There is a certain amount of dust in turning the malts on any of the floors.

8964. But the dust, if it was all deposited in the hot-air chamber, would not contain arsenic?—The dust in the chamber would be practically from the flues and from the malt on the bottom floor. Each floor is entirely separate.

8965. That is what I do not understand. I thought the hot air passed through the two lower floors and then passed through the third floor?—Yes.

8966. Therefore you have the hot air passing through the drier malt to the wettest malt at the top?—That is so.

8967. And it is the same air?—Yes.

8968. And you have evidence that arsenic is on the floor next to the hot-air chamber, because you say that before brushing you get traces of arsenic, and after brushing you do not?—That is only on one or two occasions. It has not been regular.

8969. But it is on some occasions?—Yes.

8970. Have you ever tried the middle floor?—No, we have not. It is only on the finished malt off the bottom floor. We tried it before being screened and brushed.

Temperature of malting floor.

8971. Could you tell me the temperatures of the different floors?—We do not take the temperature on the top floor or middle floor, but the temperature of the bottom floor is about 210° to 220°.

8972. So that really no comparative experiments have been made with regard to whether the dust in the upper floors contains traces of arsenic or not?—May I ask Mr. Thatcher a question? Have we had a sample from the top floor?

(*Mr. Thatcher.*) We found some in the dust round the iron girders, but hardly any in the malt.

(*Sir William Church.*) How do you account for anything being on the iron girders?

(*Mr. Thatcher.*) It is simply carried up by the fan. We have a fan at the top of the kiln which practically creates a draught so strong that when you open the door you can hardly stand. It carries everything upwards.

(*Sir William Church.*) From the hot-air chamber?

(*Mr. Thatcher.*) Yes.

(*Sir William Church.*) That is carried up flues and not through the malt?

(*Mr. Thatcher.*) No, it goes up the side. The great thing about this kiln is that if you can get the green malt without any arsenic, should any contamination result from the dried malt it can be easily brushed off, but on the green malt it cannot be so easily removed by brushing. That is the great object of this kiln, and the analytical results show it.

(*Sir William Church.*) I do not understand it as proved.

Testing malts for arsenic.

8973. (*Chairman.*) In some cases arsenic has been found—in rare cases, I think you say?—Yes, on the bottom floor.

8974. You do not know in which floor that arsenic got into the malt?—It would be on the bottom floor we maintain, in being dried off.

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8975. Would it not be a good thing to test malt from each floor?—We might take that suggestion.

8976. In any case in which arsenic is found in the malt on the lowest floor, you might analyse from the same malting the produce of the three floors above, and you would find in which floor the arsenic got in?—The same malt, of course, would not be on the other floor.

8977. You need to go backwards?—Yes. We should have to take the green malt first on the top floor, and then when it is let on to the second floor take a sample, and a sample when it gets on to the bottom floor. But we will adopt your suggestion and see the results.

8978. That, I think, will tell you in which floor the arsenic gets into the malt?—Yes, if there is anything at all.

8979. (*Sir William Hart-Dyke.*) You have been testing from the bottom floor because that is the article you are about to use?—Yes.

8980. That is what led you to do that?—Yes, it is the finished malt.

8981. Practically you have said to yourself, "This is the article we are going to use for brewing purposes, and before we so use it we will test whether it contains arsenic." That was your line of conduct in the management?—Yes.

8982. And you have not, therefore, tested the other floors, because in the case of the other floors it has not arrived at that stage at which it will be used for brewing purposes?—No.

8983. You have only tested it before brushing, and the brushing is the final process?—Yes.

8984. After testing it to see whether it contains arsenic, you have been in the habit of brushing it?—Yes, twice.

8985. (*Chairman.*) But it would help to avoid the introduction of arsenic in the future to learn at what stage of the process it comes in?—Yes; we will take the suggestion.

uction t kilns.

8986. (*Professor Thorpe.*) You tell us the arrangement which you described to the Chairman has been in use with practically little alteration except as regards the fuel used since 1896?—In the malting.

8987. The arrangement described here has been in use in your place since 1896?—Yes, I think that is the date when it was erected.

8988. That is previous to any trouble having arisen with regard to arsenic?—It was not known at that time.

8989. I think there is a slight inconsistency in your evidence comparing what you just now said with what you said at the outset. I think you led the Chairman to believe that if there were any arsenical contamination it would be in the top floor, viz., on the green malt?—Yes. My meaning when I said that was that I was referring to the ordinary kiln floors where they have only one floor.

8990. You are describing this arrangement?—I am sorry if I gave the Chairman a misunderstanding there. I was referring to the old arrangement—one floor. They simply have a distributing pan over the fire. The fumes come in direct contact with the green malt.

8991. As your evidence will be on the Notes, it certainly will appear that in your opinion the greatest contamination came on the green malt on the top floor?—I do not want to give that impression, sir.

8992. That is what I want to get quite clearly from you, that that is not what you mean?—We maintain that is our safety.

8993. You think now, whatever arsenical contamination there will be, will be on the floor where you finish off?—Yes.

8994. That is the lowest floor?—Yes.

8995. There the maximum amount of arsenic, if any, will be found?—Exactly.

8996. Of course, that fan which is arranged at the top is running at a pretty high velocity?—Exactly.

8997. There is a considerable volume of air being drawn through the whole system; is that so?—Yes.

8998. Have you any idea how much air is travelling through there?—I have no idea.

8999. We have heard from Mr. Thatcher that there is a very considerable volume of air passing through?—Yes, a great volume.

9000. You are of opinion that the greater quantity of the arsenic which may be volatilised from the fuel will be condensed as dust in the hot-air chamber?—Yes.

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9001. But will it settle, considering that the air is travelling at this high velocity through that hot-air chamber?—It does not disturb anything in the hot-air chamber at all.

9002. But supposing even that arsenic is volatilised and then condenses as solid particles of arsenious oxide, they will be mechanically swept along in the air current?—It would be impossible owing to the construction of the kiln.

9003. But the air current is moving, and this matter must be swept along with it?—There is corn on both the floors; there is not a free passage from one floor to the other. At the time the green malt is on the top floor there are malts in different stages on the other floors.

9004. Do not let us get at cross purposes. If there is an air current travelling at this velocity the condensed matter, the solid particles, that is, will be mechanically swept along?—In my opinion they would be carried up the flues, and not come in contact with the corn at all.

9005. That may or may not be the case, but to the extent that the air passes through the corn the particles will be carried on, and they will be obviously filtered out by having to pass through the interstices of the grains. That will act as a great filtering agent. The dust-laden air will be more or less filtered by being passed through that grain?—Certainly; it will act as a filter.

9006. Very well; but you say in addition to the air percolating or transpiring through the mass of the grain, a considerable volume of air is going up through the flues?—Yes.

9007. And that which does not escape filtration by means of the malt on the several floors will be carried along in the flues—is not that so?—Yes, I should say so, and would go out through the fan.

9008. What are the diameters of these flues?—I could not say exactly.

9009. Is there any dust found in those flues?—Yes; there will be a certain amount of dust.

9010. The walls are more or less rough, of course. They are brick?—Yes.

9011. There will be a certain deposit along the rough side?—Yes.

(*Mr. Thatcher.*) The walls are glazed tiles.

9012. (*Professor Thorpe.*) Glazed tiles; is there any deposit on those glazed tiles?—No.

9013. In so far as the dust is there it will be carried into the upper chamber; is not that so?—That will be taken out by the fan.

9014. May I point out that your drawing shows that the flue ends in the upper chamber above the third floors?—Yes.

9015. These you tell me are iron girders?—Yes.

9016. On which you have already told us occasionally the dust settles?—Yes.

9017. From time to time unless those girders are looked to that dust will fall down?—Those girders are cleaned.

Necessity of cleansing girders, &c.

9018. Are they systematically cleaned?—Yes.

9019. Have they been always cleaned?—Yes, always.

9020. Since 1896?—Yes.

9021. Is it a constant practice of maltsters to clean their girders?—Yes, they should clean everything.

9022. They should, but do they?—Well, I should say so. Cleanliness is a very great thing in the maltings.

9023. You had a chemist you told us since 1901?—Yes.

Extent of analyses since 1901.

9024. Has he been exclusively occupied in testing the materials you used?—No.

9025. What are his other duties?—He is an expert brewer and analyst. Mr. Thatcher is here.

(*Mr. Thatcher.*) I am that gentleman, sir.

(*Professor Thorpe.*) Let us know precisely what you have been doing. Are you a brewer or chemical analyst?

(*Mr. Thatcher.*) I am head brewer to Marston, Thomas and Sons, Limited, Burton-on-Trent. That is my pro-

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fession, and I do a large amount of analytical work, consulting work, among brewers in England and Ireland.

9026. You are not in direct employment of Messrs. Whitaker?

(*Mr. Thatcher.*) No; they send me samples.

9027. You are merely their consulting chemist?

(*Mr. Thatcher.*) Yes; that is all.

9028. (*Professor Thorpe.*) You do not dispute, Mr. Thompson, that arsenic is to a greater or less extent in your beer?

(*Witness.*) Yes, we do.

9029. That it has never been in?—There have been traces, but it has not been general.

9030. The discrepancies to which you have alluded as between different analysts are they very serious, or are they we will say of such an order as that one man says 1-50th, another man says 1-70th, and another 1-100th of a grain?—No; they are wider than that; I would much rather not give any amounts.

9031. (*Sir William Church.*) You will give us the amounts privately?—Yes.

9032. *Dr. Whitelegge.*) You told us that Mr. Thatcher had examined samples almost every week?—Yes, weekly

9033. For arsenic?—For arsenic.

9034. And has that been so since June, 1901?—Practically so.

9035. You directed his attention to arsenic?—Yes.

9036. You have given us some results of analyses, and you told us that there were traces of arsenic found in the dust from the finished malt on the first floor?—Yes, and the dust chamber.

9037. Was that found by Mr. Thatcher?—Yes.

9038. Can you tell us anything further as to the amount found?—No, Mr. Thatcher has never tried to estimate the amount.

9039. So that it was merely a qualitative analysis?—Yes. We called it either a slight trace or heavy trace as the case might be.

9040. At what time was that examination made; before you gave up the use of gas coke or since?—Before and since.

9041. And even since a trace of arsenic has been found?—Perhaps Mr. Thatcher can give the date.

(*Mr. Thatcher.*) That would be the 31st January this year.

9042. At the time when dust was found on the girders in the top chamber was gas coke being used?—Yes.

9043. So that you are not able to tell us what is found in the dust on the girders of the top chamber with the use of oven coke?—No.

Analysis of fuels.

9044. Is the oven coke examined by Mr. Thatcher?—Yes; he has had a sample of it.

9045. One sample only?—Yes.

9046. Does that one sample represent the whole of the oven coke you have used, or have you obtained a number of consignments?—We have obtained a number; we are continually using it.

9047. But the one examination was negative, confirming the certificate?—Yes.

9048. And you rely upon that?—Yes.

Selection of anthracite.

9049. Has the anthracite been examined by Mr. Thatcher?—Yes.

9050. With a negative result?—I think he said there was a slight trace in it.

9051. Is it picked over?—Yes.

9052. By whom?—It is not picked in the brewery.

9053. But it comes to you guaranteed as being picked?—Yes.

9054. Is it subjected to any examination so that if there were any pyrites in it it would be found?—Of course, we have called our maltster's attention to it. I think he would remove them if he saw them. I have never come across any myself.

Gas coke abandoned.

9055. You have changed your practice with regard to gas coke. Do you regard it as wrong to use gas coke in malting?—I cannot say that we did in ours.

9056. You do not regard it as wrong?—No, not in ours.

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9057. Because of the construction of your kiln?—Exactly.

9058. But still you have made the change?—We have made the change to remove any prejudice which might exist by our using gas coke. As other brewers are using oven coke and anthracite we have followed the same system.

9059. Would you hold yourselves at liberty as brewers to revert to the use of gas coke?—I do not think we could now. We have no intention of going back again. We want to place ourselves in line with other brewers.

9060. You have read, no doubt, the Report of the Manchester Brewers' Expert Committee?—I cannot say I have.

Recommendation of Brewers' Expert Committee not adopted at Messrs. Whitaker's.

9061. Do you know that one of their recommendations, dated May 11, 1901, is to this effect: "We recommend, therefore, that the maltster be required to give a guarantee to the brewer that he does not employ gas coke in the preparation of his malt"?—My attention has been called to that.

9062. But still you did not alter your practice until six months later?—I did not know of it at the time. It is only recently I have had my attention called to that.

9063. You are not aware, perhaps, that a similar recommendation was made in the preliminary report of this Commission?—I submitted our malts to analysts. They have been certified as being free. We did not think it desirable to change.

9064. But you did not comply with this recommendation. I understand you were not aware of it until many months afterwards?—Exactly.

Construction of kiln.

9065. As I understand you the novelty in the construction of your kiln was not originally aimed against arsenic?—No. I do not think it was known at the time.

9066. But you think it happens to exclude arsenic now that that danger is known?—Exactly.

9067. The novelty is in two directions: first that you have three floors instead of one; and secondly, what you call the dust chamber?—Yes.

9068. Is the dust chamber to be regarded as peculiar to your kiln. Is there not something corresponding to that dust chamber in almost every malt kiln?—The ordinary kiln has simply a plate, a disperser underneath the floor.

9069. What do you claim for your kiln more than an increased degree of that dispersing plate?—By the hot-air chamber.

9070. Is not the hot-air chamber common to all?—It is arched over the fires.

9071. Does it amount to this, that instead of the ordinary baffle plate you have a special baffle plate?—No, it is not a plate; it is bricked over.

9072. Of whatever material, does it not amount to this, that in your kiln the ordinary baffle plate is enlarged and has a different shape?—It entirely covers the whole of the fires.

9073. A large baffle plate can easily cover the whole of the fire, but does it amount to more than a baffle plate?—I think it does.

9074. Will you explain in what way?—By being covered, by being bricked and arched over, the floor is covered entirely, and I do not think it is by a plate altogether.

9075. Do you suggest that by reason of it being larger and of its shape and position it intercepts more of any arsenic dust and fumes than an ordinary baffle plate would?—I should say so.

9076. But you admit that arsenic does pass by it and gain access at all events to the lower parts?—In very small quantities.

9077. Truly, but some arsenic is passed?—Certainly.

9078. Has the arsenic which is found on the girders at the top also passed that baffle plate?—I should say so.

9079. I gather from the sketch here that it must do?—Certainly.

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9080. So that all you claim for this is that its construction is such as to intercept more of the arsenic dust and fumes?—Yes.

9081. But not by any means to intercept all?—No.

9082. I understand another peculiarity in your works is that the malt is brushed twice?—Yes.

9083. That has been always your practice?—Yes.

9084. Is that an invariable practice of yours?—Yes. It has been since the kilns were erected.

9085. Would you say it was wrong to omit brushing in the case of any malt?—I should, at the present time.

9086. By reason of the danger of arsenic?—Yes.

9087. (*Professor Thorpe.*) Why do you mean at the present time?—Since the arsenic scare.

9088. But you do not contemplate reverting to the old state of things. When you say "at the present time," you mean in the light of present information that it would be wrong to omit it?—Certainly.

9089. But with the idea of continuing to practice it?—Certainly. We have had it always, and should not now alter our system.

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JAMES THOMAS NEECH, M.D., D.P.H., Medical Officer of Health, called; and Examined.

9090. (*Chairman.*) You are Medical Officer of Health to the Borough of Halifax?—I am.

9091. We have had your report on the outbreak of arsenical poisoning in the borough?—Yes.

9092. And you have seen Mr. Hammond Smith's draft report?—I have.

9093. As regards the points raised by the last witness, can you say whether the man Whalan was a regular customer at the York Inn, supplied by Messrs Whitaker?—That is my information.

9094. From trustworthy information or conjecture?—I think trustworthy. It was obtained by my food inspector, and obtained not only from the man himself, but also from his son and his daughter.

9095. Can you say from enquiries whether the man Marsden frequented one or more of Messrs. Whitaker's houses?—The man Marsden frequented a house which was not a tied house, which was supplied at the time by Messrs. Whitaker. The same house, the "Moor Cock," had been also supplied partially by another brewery.

9096. In your report you deal with the eight cases Mr. Hammond Smith dealt with, and appear to have come to the same conclusion?—Yes.

9097. But there are other cases which we have not heard of so far. What were they, and from whence did these additional cases obtain their beer?—Case No. 8 in my report is a case which was received into the Poor Law Hospital, the same hospital as the cases were admitted to, which Mr. Smith saw. The case was received on March 1st complaining of symptoms which there is not the slightest doubt were due to arsenical poisoning. He had been in the habit of drinking Messrs. Whitaker's beer, Messrs. Alderson's beer, Messrs. Stocks' beer, and also had beer from Mr. Swift, of the "Cross Keys." The next case was a private patient, which I omit, as you have already received a report about it from Mr. Hammond Smith. Then there is private patient B. C., which was not a particularly well-marked case, but a slight case. Still, on examination, when I saw this case, which was reported to me privately and confidentially by a medical man, I quite thought it was a case of arsenic poisoning. This patient had her beer from a house or shop belonging to Messrs. Whitaker. Private patient C. D. in my report, also a female, was, I think, an undoubted case. There was more pigmentation in this case than in the previous case. She had been drinking beer supplied by Messrs. Alderson and Messrs. Whitaker. Private patient D. E. was an undoubted well-marked case, and he had been having his beer from the same places, Messrs. Alderson and Messrs. Whitaker. There has been also admitted within the last few days another case of a female, Elizabeth Marshall, who is, I consider, a well-marked case. She practically has all the symptoms of arsenical poisoning. She tells me that up to twelve months ago she never tasted drink of any kind, and about twelve months ago she went to live as servant at a house called the "Duke of Leeds," evidently her intemperance began when she went to the public-house. She lived at that house for six months, and had also beer from a house called the "Malt Shovel." She had been drinking whisky as well in considerable amount recently. The "Malt Shovel" belongs to Messrs. Webster. The "Duke of Leeds" belongs to Messrs. Bentley and Shaw, Lockwood Brewery, Huddersfield. Those are all the cases, thirteen cases in all.

9098. (*Sir William Hart-Dyke.*) I think you say in your report, after quoting certain results on page 13: "The above results certainly prove beyond any doubt that there was arsenic present in the beer sold in Halifax, and in several cases the amount found was dangerous in quantity." What should you define as a "dangerous quantity" of arsenic either in malt or in the finished material?—I think when we come to 1-50th of a grain it is certainly dangerous. I think no more than 1-100th of a grain ought to be allowed.

9099. You describe anything between 1-50 and 1-100th of a grain as negligible?—I should not like to do so.

9100. Do you think that where a man was an excessive beer drinker, constantly imbibing beer, anything between 1-50th and 1-100th of a grain in such beer would affect his health materially, or cause the symptoms such as you describe in one or two patients?—In some people. In persons who were susceptible to the poison of arsenic it might do.

9101. You are aware that the last witness referred to the difference in the results of analyses for the detection of arsenic?—Yes.

9102. You refer to that yourself in your report?—Yes, but only with regard to beer.

9103. You consider it is more difficult to ascertain with accuracy the quantity of arsenic there might be in beer than if you were examining malt?—Of course, I am not an analytical chemist.

9104. Quite so; but you refer to this in your report?—I have one or two ideas upon it which I have put in this report. Those ideas have occurred to me as the result of certain analyses which have been supplied to me. For instance, yeast takes up a considerable quantity of arsenic.

Arsenic in sediment of casks and in yeast.

9105. With much greater facility than other ingredients?—Yes. The beer drawn from the bottom of the cask, if taken from the cask, and I think when beer is rapidly drawn off from the bottom of the cask a larger amount of yeast cells are likely to get in the second and third sample than the first sample taken out, especially when you get near the bottom and when the cask is tilted.

9106. You think that if a customer goes to a public-house very thirsty and happens to have a glass of beer from the bottom of the cask he would run a graver risk from arsenical poisoning than the more fortunate customer who arrived at the beginning of a new cask?—I do not say he would get sufficient in the single drink to do any injury. I only make that suggestion in regard to the variation in the analysis. With regard to malt, I take it, that vapours of arsenic are liable to pass through certain parts of the kiln floors, and in that way samples will vary taken from various parts of the kiln floor.

Divergent analytical results.

9107. You put two points in your report where you say that the great difficulty of analysis arises probably from the difference in the methods used. That is rather a wide term, is it not? If there is a difference in the methods used for analysis there will be very divergent results, will there not?—I have had some experience of that. Our borough analyst has been using Reinsch's test up to a little time ago, and I find that other analysts have been using other tests.

9108. And then when it comes to the final result of the analysis, after all, it is a question of estimate where these very minute quantities have to be ascertained?—That is so.

9109. They are practically ascertained at the end by estimate?—Yes, by judgment.

9110. Therefore a certain amount of conjecture must come into the analysis?—There is, of course, an error of judgment to allow for.

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9111. But whatever difficulties there might be as regards analysis, I suppose you wish the Commission to understand, speaking as a medical man, that you have no doubt whatever in regard to these symptoms?—Not the slightest doubt.

9112. In the case of one or two of these patients you have no doubt whatever, speaking as a medical man, that these symptoms proceeded direct from arsenical poisoning, whether to a smaller or a greater extent?—I have no doubt about it.

9113. You refer later in your report to other analyses which were taken with regard to beers which were brewed after these occurrences. Your report deals on page 15 with the analytical results of certain samples of malt taken?—Yes. I am referring to the malts there. These are analyses of malts.

Difference between 1900–1 and 1901–2 malts.

9114. But with regard to this malt, were these samples malted after the deaths had taken place which led you to the enquiry?—I could not give the exact dates when these were malted, but all these malts are this season's malts.

9115. But they have borne, I presume, a severe test of analysis?—They were tested by Mr. Richardson, of Bradford.

9116. But they show an infinitesimal quantity?—Very small quantities.

9117. A negligible quantity?—A negligible quantity.

9118. That is to say, they either show on analysis that there was no arsenic whatever in these samples or the quantities in each case were of a negligible character?—That is so.

9119. Would that rather lead you to this conclusion, that in the case of these patients mentioned in your report if the poisoning took place it was rather through carelessness in the cleaning of malt?—No, I think the conclusion they point to rather is that—and from information we got through our investigations—they arose from beers which were brewed from older malt—the previous season's malt.

9120. But my point is this, that there were two classes of specimens, if I may so term it?—These are all new malts.

Implicated beer from 1900–1 malt

9121. Yes, but the beer from which the patients suffered was brewed from the older malts?—Yes. And unfortunately we were unable to secure samples of these malts. I was unable to secure a single sample.

9122. In that case you could only analyse the beer?—Yes, only the beer.

9123. Surely you must have in your mind how this arsenic appeared in the beer? The question I am putting to you is, Are you of opinion that this beer was contaminated by arsenic through the medium of malt?—That is my opinion.

9124. Do you not also consider that there was not sufficient care, for instance, in the fuel used for this malt: that there was some carelessness with regard to the use of fuel, picking it, examining it before use, or the class of fuel used: some carelessness which contaminated this malt?—Yes; I think gas coke was chiefly used during the previous season's malting.

dried over gas coke.

9125. Do you think the use of gas coke was really the cause of it?—I think so.

9126. As these other samples were taken subsequently, do you not think it was the greater care taken which produced those samples?—That is the only opinion that one can come to.

9127. Very well, then. Is not the result in your mind at this moment, after all these investigations, that care in the use of fuel or as regards the class of fuel used should be taken in the future?—Yes; greater care should be taken in regard to the fuel in the future, certainly.

Arsenical poisoning in Halifax in 1900.

9128. (*Chairman.*) Have you known of any arsenical poisoning in Halifax attributed to beer before this outbreak?—I saw during the Manchester scare one or two cases, I cannot remember which, in the workhouse during that scare; and I also heard there were one or two cases in private, but the doctors at that time refused to give me the names, so that I was unable to see them, and of course could not investigate the cases myself.

9129. Between the Manchester scare, and this recent outbreak in Halifax, had you any reason to expect that prejudicial quantities of arsenic might be present in the Halifax beer?—No reason whatever.

Experiments in miniature kiln.

9130. Have you any results to give on the experiments mentioned on page 20 of your report?—Mr. Buckley, the managing director of Messrs. Webster and Company, kindly had erected for me a small experimental kiln at his maltings, and I have made a few experiments on that kiln with the able assistance of Mr. Heard, their head brewer, who was a great help to me in the matter, but unfortunately I have been so busy during the last few months that I have not carried out the number of experiments I hoped to do. I have, however, carried out four experiments. In the first experiments ordinary gas coke was used, and the malt was placed upon the kiln in a very wet condition. The analysis of the first malting is as follows: Firstly, unbrushed malt was found by Mr. Richardson to contain 1-355th grain of arsenic per lb.; the brushed malt of the same malting 1-285th of a grain per lb.

9131. (*Chairman.*) That is rather more than the unbrushed?—Yes. We shall see directly how it comes about. In No. 2 experiment the malt was hand dried, and put on to this small kiln practically dry. On analysis it was found unbrushed to contain 1-200th of a grain of arsenic per lb. The brushed malt was found to contain 1-230th grain of arsenic per lb. Both these samples were malted with ordinary gas coke—Halifax gas coke. The next two samples were also malted with Halifax gas coke, but I arsenicated the coke with a small quantity of arsenate of sodium, and I arsenicated the coke as evenly as I possibly could from judgment. The first experiment, again very wet malt, was applied to the kiln, and on analysis that gave 1-9th of a grain of arsenic per lb. The same malt brushed on analysis gave 1-8th of a grain per lb. In Experiment 4, with the same coke and arsenicated, as far as one can judge exactly the same, the malt was put on dry, exactly as in the second experiment, and on analysis it gave 1-18th of a grain of arsenic per lb. unbrushed, and brushed it gave 1-24th of a grain per lb.

9132. (*Sir William Hart-Dyke.*) It was an ordinary kiln, I suppose?—No, an experimental kiln.

9133. (*Professor Thorpe.*) How did its construction differ?—We put in two floors really, but it was only the upper floor we used, so that the space between the lower floor and the upper floor might act as a sort of distributing chamber.

9134. (*Sir William Hart-Dyke.*) But the fumes were direct?—Yes; the fumes went direct through the malt straight from the fuel.

9135. There was no check?—No check except this chamber between. Both floors were made of perforated tiles, so that the fumes went direct through. In the brushed malt of No. 2 experiment, and the brushed malt of No. 4 experiment, I removed the husk of a small quantity of each, and submitted them to Mr. Richardson for analysis. The grain after the removal of the husk gave these results: From the brushed malt of No. 2 experiment, 1-300th of a grain of arsenic per lb.; from the brushed malt of No. 4 experiment, 1-210th grain of arsenic per lb. That showed that arsenic does even penetrate the centre of the malt, but it is chiefly deposited in the husk.

9136. (*Chairman.*) All that is in the husk is removed by brushing, or can be removed by brushing?—No. It is a very tedious process removing the husks.

9137. So that brushing does not remove all the arsenic from the husk?—No, I think not.

9138. And, of course, it does not remove arsenic from the core?—No, not from the interior. I was rather astonished at these experiments. I expected to find that the wet malt would take up more arsenic than the dry malt. These experiments are too few to dogmatise, but I expected the wet malt to take up more arsenic than dry malt. In the first two experiments made with ordinary coke the dry malt took up rather more arsenic than the wet malt, but, of course, ordinary coke may vary; there might be more arsenic in one lot of coke used than in the other, although it was from the same bulk. But in the second pair of experiments I think the coke was practcially the same, as far as I could judge. The dry malt, hand-dried and practically dry before being put on the kiln, took up only half the amount of arsenic that the wet malt did. The wet malt when brushed seemed to show more arsenic than unbrushed. The dry malt shows rather less arsenic after it is brushed than before being brushed. Mr. Richardson made analyses of the culms from the third and fourth lots of malt. The culms

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from the malt in the third experiment gave 7·20th of a grain per lb., which is rather over 1-3rd of a grain per lb. The culms in the malt of the fourth experiment gave 1-26th of a grain per lb.

9139. (*Chairman.*) How do you account for the greater difference?—In the one case the malt was very wet when it was put on the kiln, and in the second case the malt was dry when it was put on the kiln. The culms of the dry malt took up less arsenic than the culms of the wet malt. Mr. Richardson says: "No. 7 culms gave an unexpected result (No. 7 is the culms of the dry malt) as they contained a trifle less arsenic than the brushed malt, and yet I have no doubt as to the result. It is possible that in some cases the culms may not take up any more arsenic than the grains themselves." Then he says, "I think I can account for the slight difference in the result of the analyses of the malts. At the bottom of the packet containing the malt I have found a quantity of the culms which seem to have broken off, and settled to the bottom; and it will interest you to know that in No. 5 malt (the malt of the third experiment) the culms contain ·28 grain of arsenic per lb., and this, as you will allow, is a very large quantity; and it would seem to be very difficult to mix these culms with the malt grains so as to make an average sample in a small way." I take it from what Mr. Richardson says, the reason why the brushed malt in the third experiment contains more arsenic than the unbrushed was because the culms contain an excessive amount of arsenic.

9140. (*Professor Thorpe.*) Before you pass to another point may I ask whether steps were taken to ascertain that the barley itself was free from arsenic?—No. I did not take any steps to see that. As far as I understand, it was the same barley in each case that was used. These experiments were all done in the course of a few days. These would be two maltings of the firm. The malt was taken from the ordinary germinating floors of the malt kiln, and No. 1 and No. 2 experiments would be exactly from the same malting, and No. 3 and 4 from the same malting.

(*Mr. Buckley.*) Our barley was examined before it was malted.

9141. (*Sir William Church.*) Your experiments would lead us to think that brushing is not so great a safeguard as the last witness, for instance, wished us to conclude?

(*Witness.*) Of course these experiments are only a few in number, and I should not like to dogmatise upon them, but these experiments seem to indicate that.

9142. With regard to the first experiment with the wet malt in which the culms took up so much, they would make a very much closer filter bed when they were wet and swollen than dry malt?—They would, and also I should think any arsenic that was present would more readily penetrate the soft culm than the hard dry one.

9143. Could you tell us what the temperature of the escaping fumes would be from the green malt in these experiments?—I should think nearly 200°.

(*Mr. Buckley.*) About 200°.

9144. (*Sir William Church.*) After having passed through the malt?

(*Witness.*) No. The thermometer in the malt showed from 150° to 200°, I believe.

9145. You are not a professed chemist?—No, I am not.

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9146. Might I just ask you a question or two upon your report? Did you see McNulty during life?—I did not.

9147. Were you present at the inquest?—I was.

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9148. You said, "Dr. Woodyatt was examined, and gave it as his opinion that the deceased had not suffered from arsenical poisoning, and did not die from the effects thereof." Are you quite certain of that?—That was the impression I gathered from his evidence.

9149. What I gathered was that it seems to me Dr. Woodyatt might have said the man did not die from arsenical poisoning, but that would not be any reason why the man was not suffering from it. A man need not necessarily die from the poisoning; he might die from something else?—That was what I really gathered from his evidence.

9150. What I want to be clear of is that he gave his opinion that the deceased had not suffered from arsenical poisoning?—Perhaps it ought to have been, "did not suffer at the time."

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9151. Or, put it in another way, your impression was that Dr. Woodyatt's evidence went to show that he did not think the man had at any time suffered from arsenical poisoning?—At that time. At the time while he was under his care that was the impression. That was the impression I gained, and the impression I intended to convey here.

9152. What were his grounds for coming to that conclusion?—I understand his grounds were the conditions he found on the post-mortem examination, which are given in the appendix to my Report. He thought the pigmentation was not due to arsenic in this case. I remember he stated that.

9153. Did he explain the condition of the heart?—Yes.

9154. What did he consider it was due to? You will see in the appendix you say the heart was dilated and very flabby?—He admitted that.

9155. His opinion was that the bronchitis which apparently was what killed the man was not connected with his general sate of health which might have been produced by arsenic?—I do not think he considered his general state of health was due to arsenic. That was my impression. He did not say it was not, but only gave it as his opinion.

Lee's case, Dr. Woodyatt's evidence.

9156. Did you see Thomas Lee?—I did. I have some photographs. (*Photographs shown.*) The dark man is Thomas Lee, and the other is put by the side of him to show the difference between the two.

9157. (*Chairman.*) Was he dark all over like a negro?—Yes.

9158. Is that exaggerated in the photograph?—I do not think so. When I first saw him he was practically as dark as that.

9159. And the darkening is pigmentation all over?—Yes.

9160. (*Sir William Church.*) In the case of Thomas Lee, did you attend the coroner's inquest?—I did.

9161. Dr. Woodyatt in that case was of opinion that death was not caused by arsenic?—He was; but he admitted that the man was suffering from arsenical poisoning on his admission to the hospital.

9162. That is the point I wanted to draw out. You do not know whether he admitted that in the case of McNulty?—I do not know.

9163. But he did not question it in the case of Lee? He only questioned what was the immediate cause of death. He did not question that Lee suffered from arsenical poisoning?—No; he admitted that.

9164. But he was of opinion that recent pneumonia was the actual cause of death?—That was his opinion.

9165. There is no reason why pneumonia should not occur, is there, in arsenical poisoning?—I think it is very liable to occur.

9166. Is it within your own knowledge that with cases of arsenical poisoning the actual cause of death has been pneumonia?—Not from observation, but only from reading.

9167. You did not see any?—I have only seen actual post-mortems in these cases at Halifax. I have read the accounts of the Manchester cases.

Other infirmary cases.

9168. Could you tell us whether you know what Dr. Woodyatt's opinion was of the other cases, Louisa Lowry?—Louisa Lowry is not Dr. Woodyatt's case. It belongs to the other visiting medical officer, Dr. Shaw. This case was shown to our Medical Society as a case of arsenical poisoning, so that I take it he must have a definite opinion with reference thereto. (*Photograph shown.*)

9169. Nancy Wilkinson was not Dr. Woodyatt's patient?—No, but I think it was an undoubted case.

9170. And Shearing was not Dr. Woodyatt's patient?—Yes; Shearing was his patient. The same thing happened with regard to Shearing. He showed it at our Society as a case, so that I take it he has made up his mind it is a case.

9171. Did you see Marsden yourself?—I did.

9172. Were you of opinion that he was suffering from arsenical poisoning?—I was.

9173. He is now, I think, discharged from the hospital?—Yes; I do not know where he is now.

9174. Did you see Whalan?—I did.

9175. Was it your opinion that he was suffering from arsenical poisoning?—It was. *That* is the man. (*Photograph shown.*)

Whalan's case one of arsenical poisoning.

9176. Whalan is now dead?—Yes.

9177. There was no coroner's inquest upon him, was there?—No.

9178. You had no doubt Whalan was suffering from arsenical poisoning?—No doubt at all.

9179. Do you know what Dr. Woodyatt put on his certificate?—Pernicious anæmia. Of course the man suffered from anæmia, but I have ascertained that Dr. Hodgson carefully examined the blood on several occasions and, while the blood gave indications of anæmia, it did not of pernicious anæmia. There was not the irregularity in shape of the blood corpuscles, and the blood corpuscles formed very good *rouleaux*. I think that is an indication rather against pernicious anæmia.

9180. The symptoms of arsenical poisoning and those of pernicious anæmia are very similar in many ways?—Yes. But as far as my investigations go, and I have only investigated the blood conditions of these cases with Dr. Hodgson. I have seen his specimens, and as far as my experience of these cases go the blood corpuscles formed *rouleaux* very freely, which does not happen in pernicious anæmia.

9181. Was there any determination made in the amount of hæmoglobin?—Yes, Dr. Hodgson has done that, but I did not bring the figures.

9182. Were you of opinion that the coroner ought to have had an inquest on Whalan?—A difficulty arises when a medical man has given a certificate; I should not like to say he ought.

9183. Perhaps I ought not to have asked that question. Had you communicated with the coroner about Whalan?—Yes, I saw him. I believe I had a chat with the coroner on the same day he died.

9184. But you had no official communication?—No, nothing official. It was simply an unofficial chat I had with him.

9185. The coroner did not refer to you officially?—No. The only time the coroner referred to me was in the case of McNulty, the first case. He officially telephoned to me, and gave me the information with regard to McNulty and the other cases which were in hospital.

9186. I think we ought to have it on the Notes; who is the coroner now?—Mr. Hill. He is mentioned in the first page of my report.

9187. Is he a medical man or not?—A lawyer.

9188. I think John Whitehall was not Dr. Woodyatt's patient?—Yes, he was. All males are his patients in the hospitals at present, and all females Dr. Shaw's patients.

9189. Did you see him yourself?—Yes.

9190. Had you any doubts as to his case?—No.

9191. (*Chairman.*) Did John Whitehall die?—No, he is not dead; I believe he is discharged.

9192. (*Dr. Whitelegge.*) In your experiments did you make any determinations of the arsenic in the dust?—No, I did not.

No beer officially taken between 1900 epidemic and outbreak.

9193. During 1901 were any samples of beer taken in Halifax officially for analysis under the Sale of Food and Drugs Act?—I believe there was one sample taken, but that would be in the very beginning of 1901, after the official samples which we took during the Manchester scare.

9194. What date would those samples be taken?—I am sorry I cannot give you the date. Unfortunately I did not remember to bring the certificates which I got from the analyst in those cases.

9195. During 1901, apart from any samples which were taken at the time of the Manchester outbreak, there were none officially taken?—None at all that I am aware of.

9196. Is it not the practice to take samples of beer among other things?—I had never taken samples of beer prior to the Manchester scare.

9197. I am speaking now of the period since the Manchester scare?—I did not take any samples during the course of 1901. I had no reason to suspect. I thought with everybody else that with Bostock sugar the arsenic scare had gone. I had heard that malt was somewhat liable to be arsenical, but I had no idea whatever that Yorkshire malt was more specially liable than any other malt.

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9198. In the light of what has happened, would you propose to take samples of beer in future years as a matter of routine?—Yes.

9199. Every year?—Every year.

9200. And quite apart from any outbreak, locally or otherwise?—Yes, certainly.

9201. After the Manchester outbreak did you receive any instructions from the Local Government Board specially bearing on the question of arsenic?—I think we did receive a circular, but I do not remember.

Action by M.O.H.

9202. Will you tell us briefly what steps you took as Medical Officer of Health regarding the outbreak?—The recent outbreak or the first outbreak?

beer samples taken.

9203. The recent outbreak?—As soon as I became aware of the existence of these cases in Halifax I at once had samples of beer taken, and submitted them to analysis.

Reports by public analyst.

9204. How many?—In the first lot there were six, and they were submitted to our public analyst, whose certificates are here. He reported them to be absolutely free. The six were taken on January 13. Then I heard privately that a certain brewery was suspected, and I had samples taken of those beers.

9205. Are these certificates in the ordinary terms which Mr. Ackroyd uses?—Those are the ordinary certificates he sends in. In case of prosecution he makes out a special certificate.

9206. You understand the certificate to mean absolute freedom from arsenic?—Yes, in those cases.

9207. Beyond taking these samples, what did you do?—On January 17 there were three other samples taken. On January 18 two others from this suspected house; on the 21st three more; on the 17th two more from the same house; on January 20 a further one from the suspected house, and four others. On January 24 twelve samples were taken. On the 25th two from the same suspected house again.

9208. We will take it generally you took a number of samples, guided by such clues as you have, and submitted those officially?—I submitted the first lot to Mr. Ackroyd, and he found in one sample a sublimate of some kind which he could not say was arsenic or not, and I was specially suspicious that there was arsenic in this beer. I consulted with my Chairman and the Town Clerk, and we submitted samples to Mr. Richardson, of Bradford.

Mr. Richardson's reports.

9209. So that you took samples and submitted them for examination both officially and unofficially?—Yes. This was just after McNulty's case. I took twelve official samples, which I did not know what to do with for a time.

9210. What did you do with them?—Eventually I sent them to Mr. Allen for analysis. I was rather awkwardly placed with regard to our public analyst. He had said there was no arsenic present in the beer, and then Mr. Richardson sent me reports showing there was arsenic, especially in two samples I sent; and that was the position of matters.

9211. Did you send the same samples to Mr. Ackroyd?—Two or three.

Mr. Ackroyd's later report.

9212. And not always with concurring results?—Mr. Ackroyd got hold of a more recent method of estimating arsenic. I sent him later one sample, which I also sent to Mr. Richardson, and Mr. Richardson reported 1-40th grain and Mr. Ackroyd 1-60th of a grain, so that there was not a great divergence. I sent also one or two to Mr. Allen, and also to Mr. Ackroyd. There was perhaps about the same divergence, or perhaps a little wider divergence in those cases.

9213. Taking it generally from one analysis or another, you had confirmation of the presence of arsenic?—Yes.

M.O.H's report to Town Council.

9214. Did you report it to the Health Committee?—This report has not yet been submitted to the Health Committee. It has been submitted to the Chairman of the Health Committee.

9215. And will no doubt come before the Town Council in due course?—Yes.

9216. Have you sent a copy of it to the Local Government Board?—I have not.

9217. Then you undertook a number of inquiries, which you mentioned in your report, inside and outside the borough?—Yes.

9218. Did you meet with any difficulty in making those inquiries?—I must say that on the whole I had no difficulty, and certainly everyone seemed, except in one case, to give me all the information and assistance they could. In one case I did get a little obstruction.

9219. Is that the one mentioned on page 10; it is outside your district, is it not?—Yes. His malt kiln was also unfortunately just outside the boundary of the district of the medical officer with whom I went.

9220. In the case of those premises you visited inside the borough, you had no difficulty in gaining admission?—No difficulty whatever.

9221. Do you consider you have any right of entry there?—Do you mean into the breweries and the maltsters' premises?

9222. Yes?—I am rather doubtful about that.

9223. At all events that question did not arise, as you met with all facilities?—I did. I did not know whether they could be entered as a workshop or not.

9224. You mentioned the samples of malt which were taken. Were those taken officially under the Sale of Food and Drugs Act?—I am afraid we cannot take malt officially.

9225. (*Professor Thorpe.*) Why not?—The malt is not on sale.

9226. But if anything enters into composition of a food, it is by statute defined to be a food, or a drink?—That may be so. But I have been looking out to see if I could find power to do that.

9227. Under the amending Act of 1899, would not you have power. There is a much wider definition given there of what a food is?—I consulted our Town Clerk, and I am not sure that I have power, and do not know whether I have power to enter into a malt house and take samples.

9228. (*Dr. Whitelegge.*) Your conclusion was reached after consulting the Town Clerk?—Yes.

9229. What do you consider your power would be to take samples in the case of beer in a brewery?—I do not know that we have power.

9230. As a matter of fact, did you take samples of malt at the maltster's and beers at the brewery?—Yes. Malt at the maltster's and beer at one or two breweries.

9231. Did you take any samples of brewing ingredients at the brewery?—All these brewing ingredients were taken at the brewery, with the exception of a few taken at malt houses.

9232. Did you inform the coroner in cases where you found reason to suppose that the cause of death was suspicious? In those cases in which it appeared that there was a question of arsenical poisoning, and which ended fatally, did you communicate with the coroner?—These cases were not under my care.

9233. They came to your knowledge officially?—Yes. They came to my knowledge, but two cases had been already reported to the coroner. The first case that died, and the second case were reported to the coroner.

9234. So that there was no occasion for you to communicate with him?—No. But in the third case I did not know whether it was going to be reported or not, and I got information of the death of Whalan, and I unofficially had a chat with the coroner.

9235. Were you in communication with the public analyst?—We have been in constant communication with one another.

9236. Were you in communication with the officers of the Board of Inland Revenue?—No.

9237. You had no conference with them?—No.

9238. I was going to ask as to the action taken by the Town Council on the receipt of your report, but I gather that the report has not reached them?—When I had the reports of Mr. Richardson giving the results of his analysis I had a consultation with the Town Clerk, and the Chairman; and Mr. Hammond Smith was present at the time.

9239. The action you have taken was with their authority as well as your own?—Yes.

9240. But without coming in any formal way before the Committee or the Town Council?—Yes.

9241. You refer in your report to some points in the faulty construction of malt kilns (page 18). Did you meet with any which were constructed in a manner which satisfied you in all respects?—Yes. There are some kilns which, as far as I know, seem to be quite up to date.

M.O.H. no knowledge as to new kilns.

9242. Are plans for new constructions of this kind submitted to the Town Council?—I think so.

9243. Do they come before you in any way?—No.

9244. Do any plans come before you?—The only plans that have come before me since I have been in Halifax chiefly are dairies and cow sheds.

9245. What amount of beer was taken for samples in Halifax?—I think usually a quart.

9246. (*Professor Thorpe.*) With respect to the point I raised, viz., as to your power to take samples of malt, you are aware that in the 1875 Act the definition of food was "Every article used for food or drink by man other than drugs or water"?—That is the original definition.

Power to take samples of malt.

9247. Are you not aware that in the present Act, the amended Act of 1899, the definition has been extended by the addition of these words, "And any article which ordinarily enters into or is used in the composition or the preparation of human food"?—Yes.

9248. Malt is used in the preparation of human food in that sense?—It is.

9249. And it is on sale by a maltster?—Yes. But there are certain steps to go through with regard to collection. I do not see how we could buy it in small quantities to submit it to analysis under the Act.

9250. You may apply for such an amount as you like, and tender what the man thinks is the equivalent value of it. You may take the malt and tender what he considers is its value?—I have not attempted anything of that kind. I have considered the matter, and I thought we had not power.

9251. Have you been advised by the Town Clerk you have no power?—I believe that was his opinion. I cannot just remember the exact grounds.

9252. With respect to the statement you made to Sir William Hart-Dyke as to your view whether these discrepancies in the statements of analyses may be accounted for, when you said that there might be an error of judgment because the amounts of arsenic were not weighed, but had to be estimated, what did you mean by that?—I take it that it is a question of judgment, and one man's judgment might differ slightly from another man's judgment.

9253. Is it your opinion that when the analyst has a small quantity in a tube he looks at it and says, "That is 1-100th of a grain or equivalent to 1-100th of a grain"?—As I told you I am not an analyst, and I have only seen these tubes. I have never made one.

9254. Are you not aware that the practice is that the analyst takes a standard tube and applies that standard?—Yes.

9255. And the standard mirror is the result of a definite amount?—Quite so.

9256. That is the way the estimation is made, a direct comparison?—Yes, I am aware of that now.

9257. Then your surmise that the discrepancies between analysts may be due to a greater or less quantity of sedimentary matter in the beer analysed is drawn from the analytical information which has been furnished you?—Yes.

Effect of sediment on analytical results.

9258. If the beer, for example, is not perfectly bright, it may happen that one analyst has taken it in the same turbid condition, and the other has drawn off his sample when the beer has been allowed to settle?—Yes.

9259. And that the suspended yeast cells, which, of course, we all know secrete or are liable to secrete quantities of arsenic, might be really the cause of the difference?—That was simply an opinion I expressed for what it was worth.

9260. I quite agree with you that is so. It is not merely an opinion, but a fact. The amount can be considerably different due to that circumstance?—How yeast cells get into it, I take it, is because beer is drawn from the bottom of the cask, and when the beer comes to get near the bottom the cask is tilted upwards.

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9261. Has it come to your knowledge that the amount of arsenic in beer is liable to alter with the age of the sample?—No, I have not heard of that.

9262. You have not heard, for example, of any moulds getting into the beer and the amount of arsenic present in solution gradually getting less and less?—I am aware that there are certain moulds that will take up arsenic besides yeast.

9263. You are not aware that as a further cause of discrepancy something may depend on the age of the sample analysed?—I have not taken any samples with the view of ascertaining anything of that kind.

9264. We have had it in evidence here by analysts that it is known the amount of arsenic tends to get less and less if the beer shows any symptoms of becoming mouldy. You are not aware of that?—I am not aware of that fact, but I can quite understand that would take place, because I know there are moulds that take up arsenic readily. I have details here of a case of arsenical poisoning with well-marked paralysis due simply to the administration of medicinal doses of arsenic. It occurred in Halifax.

Medicinal dose of arsenic causing paralysis.

9265. (*Sir William Church.*) We know that condition very well?—I have a photograph of the case here (*photograph shown*). It was due to ten minim doses daily, extending over three weeks.

Mr. F. Buckley, called; and Examined.

Mr. F. Buckley.

Halifax outbreak.

Evidence in respect of Webster's brewery.

9266. (*Chairman.*) You are managing director of Messrs. Webster and Sons' brewery at Halifax?—I am.

9267. Can you tell us what precautions regarding arsenic have been taken in your brewery during 1901, after the Manchester scare, and again since arsenic was reported in the beers at Halifax?—In November and December last year, 1901, we had all our materials analysed, and we had all our beers which were going out to our customers analysed by the borough analyst of Halifax. I sent down to Dr. Buchanan the results of the analyses of all our materials and the analyst's reports on what we have been using for the last twelve months, and we, as brewers, consider them favourable and satisfactory.

9268. On the 14th August, 1901, four samples of malt were sent to the borough analyst, is that so?—I cannot say positively, but we have sent very many samples to the borough analyst regularly.

Extent of analyses made for brewery in 1901

(*Secretary.*) Looking through the analyses which Mr. Buckley was kind enough to send in reference to the year 1901, that is the period since the Manchester scare, but before arsenic was reported in the beers at Halifax, I notice that the total number of analyses he had sent us with regard to malt were four samples on August 14th, which were sent to the borough analyst, and one sample on the 20th November, 1901, sent to the borough analyst. I do not think there were included any samples of beer at all. Very likely there were additional samples, but so far as your question, sir, is concerned, we have only evidence from the analyses which Mr. Buckley has sent us, that malts were analysed on two dates during 1901.

9269. (*Chairman.*) Have you the results of those analyses?—Yes, I think we have somewhere. There is one August 14th, 1901, from the borough analyst of Halifax.

9270. (*Sir William Hart-Dyke.*) An analysis of malt?—Yes.

9271. (*Chairman.*) How many samples?—Three samples of malt.

9272. What was the result of the analyses?—All free from arsenic.

9273. On the 20th November, 1901, what was that?—We had just built a new kiln and wished to make ourselves secure. We were afraid of a little moisture in the malt, and so sent this particular sample to ascertain what moisture was in the malt, and also any trace of arsenic. The borough analyst gives us 1·7 of moisture and no trace of arsenic on November 20th, 1901.

9274. All we have evidence of is the analyses of four samples during the year 1901?—Yes.

and since outbreak

9275. Did you have any beer examined by analysis?—The beers we have had analysed were principally this year, 1902. All the beers we have sent out we have had carefully analysed.

9276. Do you agree that, as was suggested by Mr. Hammond Smith, your brewery would have been sending out beer in December, 1901, made with malt dried in February, 1901, before you discarded gas coke?—I do.

Implicated beer made from gas coke malt.

9277. Would malt thus used have been specially tested for arsenic?—I cannot say. It was specially tested in February, 1901, but I may add we have now new machinery of the very best kind, new brushing machines, and we should not expect to find any trace of arsenic in the malt that would be detrimental to the beer.

9278. Does the new machinery include any new arrangement of kilns?—It is a perfectly new kiln, now working its second season, a very large kiln, 120 quarters.

Mr. F. Buckley.

9279. Are there special improvements in that kiln?—The latest improvements in machinery we could get without regard to cost or anything.

9280. Improvements to guard against arsenic?—Yes, and for brushing the malt to make it perfectly clean.

9281. Could you describe the precautions against arsenic shortly?—As far as the precautions against arsenic go, we have taken great precautions in drying our English barley before steeping it up to Christmas, but after that we consider it has ample time to sweat in the stack, and does not require drying. We take every precaution when we take the malt off the kiln floor to have it very carefully brushed with these machines and stacked away in the wood bins, and before it goes to the brewery, which is 100 yards away—we never keep a sack of malt at the brewery, sending it up for immediate use in small quantities—before it goes up it is carefully brushed again, so that no trace of arsenic can remain on the barley when it leaves the malt kilns.

Precautions taken against arsenic.

9282. Have you tested the effect of the brushing in removing arsenic?—I cannot say that we have. We have tested malts, of which I have submitted to you the analysts' reports of this year from Mr. Richardson, of Bradford, Mr. Hehner, of London, Mr. Thompson, of Manchester, and others. We have been most careful this year to have all our malts analysed before we use them, and all the beers before we send them out.

No experiments on effect of brushing malt.

9283. You mean in this year 1902?—Yes.

9284. Have you many analyses made in 1902?—Yes, I think you have seen them, but I will put them in again. (*Analysts' reports put in.*)

9285. What you hand in is a statement of the analyses which have been made since the beginning of 1902?—Yes.

9286. Have you any objection to the whole or any part of this being published in our report?—I would much prefer it not being published. I do not think it would be to our interest, and it would not be to the interest of the public generally to publish those reports, particularly the analysts' reports.

9287. (*Sir William Hart-Dyke.*) The analysis is very favourable, is it not, so far as your position is concerned—it rather goes to prove the precautions you have taken?—It is quite true, but there are reporters of newspapers and editors who take a liberty with the trade and do it serious injury. We as brewers in Halifax have a large Brewers' Association representing, I should think, a million of capital, and we know that the Lancashire brewers have suffered very much from the newspaper reports when they were using every effort to produce a good saleable article, the same as we are doing to-day. And that is the reason I, personally, on behalf of our firm, would very strongly object to the analyses being published; but, of course, we are in your hands. We are very wishful to give you all the assistance we possibly can.

Formation of Brewers' Association in Halifax.

9288. You are pleading this not recklessly, but after the experience of the Lancashire brewers?—Yes, and from what I have gone through personally myself these last four or five months. I have taken a great interest in this matter, and have met a medical gentleman and gone into the matter carefully, and I think it will be unwise to publish these reports.

Mr. Buckley.

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9289. (*Chairman.*) You have helped to found the Brewers' Association, I believe?—I have.

9290. You and others in the business have consulted together as to the best means of attaining to perfect security in respect to arsenic?—That is so.

9291. It is interesting for the Commissioners to have these reports of analyses. I do not think it is necessary they should be published?—I have no objection at all to the Commissioners having any particulars.

9292. (*Sir William Hart-Dyke.*) So far as I am concerned, I may say that you volunteered to give us all the information you can, and we ought to consider you?—I speak for the brewers, and I am sure we are quite willing to give you all the information we can from our books, from our breweries, and from the maltings. We are quite as anxious as you are in the public interest. I am sure that every brewer will be pleased to open his books for perusal at any time.

9293. (*Chairman.*) Could you give us any general remarks regarding the present position of the Halifax brewers as regards the arsenic question?—In the first place many of them were using gas coke or oven coke before the Manchester scare, but since then many of them have gone over to anthracite, and some of them have changed back again to coke. They found that they could produce a better malt in some cases than with anthracite, but we have never used anything but anthracite for more than five months. I think the result has proved that anthracite is far the better material to use than oven coke.

ls of fuel

9294. In what respect better?—We found the results better in our malts when we have examined them afterwards.

ntage thracite.

9295. Do you mean in the flavour of the malt?—In the less percentage of arsenic in the malt by using anthracite than with oven coke.

9296. You find it does produce a less percentage of arsenic than the coke you have been using?—Yes. We should be very glad, I am sure, if you have any suggestions to make to us as to what kind of coke to use, or anthracite. We should be very pleased if you could recommend any fuel from any particular district. It would not be a question of cost in getting that material.

9297. (*Professor Thorpe.*) The statement you have just now made is so important, namely, that in your experience a better result is given by the use of anthracite than by oven coke, that we should be glad to have the analytical evidence upon which that is based, if you can furnish us with it. It is very pertinent to the whole inquiry?—Mr. Hammond Smith will bear me out, I think, that when Dr. Smith came to Halifax about this scare in the town we immediately gave up oven coke and commenced using anthracite, and the proof is in the analyst's report now that we find less in using anthracite than by using oven coke.

9298. Have you ever used gas coke?—Yes.

9299. You are clear as to the distinction between gas and oven coke?—Quite.

9300. (*Chairman.*) Gas coke produced more arsenic in the malt than oven coke?—I would not say that in all cases. Some brewers say not. They vary very much in respect to that. If you will allow me to make a statement, we are very anxious to get at a sound basis of analysis. The Excise officers took a sample, on which I received a letter from the Inland Revenue at Somerset House on the 21st March, that the sample had been sent by the Excise and they found 1-80th of a grain per gallon. I immediately wrote in reply to say that I would send the duplicate sample to Mr. Richardson of Bradford, and would acquaint him of the fact that a sample had been sent to Somerset House to be analysed, and to most carefully give his attention to the matter, and let me have a detailed report of the analysis of the sample. Before that I had the malt that this beer was brewed from analysed, and the one sample, the Yorkshire malt, was 1-700th of a grain per lb., and the foreign 1-1000th part of a grain per lb. I then got from Mr. Richardson of Bradford an analysis of a duplicate of the sample which was sent to Somerset House, whose analysis was 1-80th, but Mr. Richardson's was 1-500th.

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9301. (*Sir William Hart-Dyke.*) An identical sample?—Yes. He said "In my opinion he is quite mistaken whoever has analysed that." I told him who it had gone to. We feel very much upset when we get two reports like that in one week from one sample of beer, divided into two, one sealed and left with us and the other sent to Somerset House. We very much desire that a second or third person should be appointed to analyse this beer, if a prosecution should be ever taken or a standard of any kind fixed upon. We are quite satisfied ourselves that this beer which is now being consumed is a good sound wholesome beer, and not detrimental to the customer, in spite of the fact that Somerset House said it had 1-80th.

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9302. (*Sir William Church.*) Might I ask what you mean by an identical sample?—The sample was taken by the Excise officer and divided into two. He seals it up, takes one away with him, and leaves the other with our brewer.

9303. (*Professor Thorpe.*) That was a sample of beer brewed on the 10th February, 1902?—It was.

9304. (*Sir William Hart-Dyke.*) You are deeply anxious, and the trade generally is deeply anxious, maltsters and brewers alike, for future security? With regard to malt dust, are you not of opinion that cleanliness in regard to this matter in all malt kilns is a very necessary element?—I am.

9305. Are you aware that in this malt dust considerable quantities of arsenic have been found?—Yes, I am quite aware of that.

9306. In that dust itself?—Yes.

9307. And you think, in addition to the extreme care in regard to the selection of fuel, that cleanliness is one of the first objects as regards the malting business?—Yes, most essential.

9308. The more especially as regards the malt dust?—Yes.

9309. Is this malt dust ever used for stock feeding purposes?—Do you mean the dust that comes from the machines?

9310. Yes?—Yes, it is.

9311. Is it used for feeding sheep and calves?—Yes, but only the culms, you know.

9312. There is a distinction between that and the dust which collects in the kiln. What is done with the dust that collects in the kiln, not the culms?—We do not sell that at all.

9313. (*Chairman.*) What is done with it; is it burned or buried?—It is carried away and put on to the tip as rubbish.

9314. (*Sir William Hart-Dyke.*) You say that you would be glad to submit to any restriction imposed as regards the use of any particular kind of fuel?—Yes.

9315. You suggested that you would be glad to get any hint with regard to the use of any particular fuel. Taking the trade generally, whether the malting or brewing trade, you would not consider it any serious monetary loss to you, or any charge upon your trade, if restrictions were placed upon you in regard to this or that kind of fuel?—No, I do not think we should object.

9316. Provided you could get security, and were in a more secure position as regards this danger?—Exactly. I may add that the maltsters and brewers in the district who are using coke and coke and anthracite mixed, are using lime, and taking all precautions possible to prevent any contamination taking place in the malt.

Maltsters now liming fuel.

9317. They are using lime, are they?—Yes, many of them.

9318. (*Professor Thorpe.*) With reference to the statement you have made as to the discrepancy between the result of different analyses, and your desire, in which I deeply sympathise, that there should be some definite method laid down, I find that the beer which was brewed on the 10th February, 1902, was reported by the Inland Revenue to contain 1-80th of a grain per gallon, whereas you say the same sample you sent to Mr. Richardson was reported to you to contain 1-500th of a grain?—That is quite true.*

Analyses differing.

9319. I find you sent to Mr. Otto Hehner a sample of your beer on the 3rd February, 1902?—Yes.†

9320. And that Mr. Hehner reported that that beer contained 1-80th of a grain per gallon?—Yes.

* This was No. 25 Gyle, brewed from all new malt.

† This beer was brewed from all old malt.

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9321. Would that beer be in any way different from the beer brewed on the 10th February?—It was not the same beer.

9322. Probably not, but would it be brewed from the same malt?—Yes, it probably would.*

9323. Then there is a substantial agreement between Mr. Hehner and what was reported from the Inland Revenue laboratory as to the amount of arsenic present?—Yes. It depends whether it was common beer or best beer.

9324. There might be a slight difference in the specific gravity no doubt, but that slight difference in the gravity would not make any very perceptible amount of difference in the result?—Would you mind my looking at Hehner's certificates? It does not say what class of beer it was.

9325. Have you any means of knowing what the original gravity of that beer would be?—I could ascertain. I could not tell you from memory now.

9326. You have no knowledge at all? Would it be a heavy or light beer?—I could not say from memory.

9327. You cannot give me any idea of any of these?—Not from memory, but I could if I were at the brewery.

9328. I also find at the same date you also sent to Mr. Hehner another sample which was marked No. 10X, and which was reported by him to contain 1-60th of a grain of arsenious oxide per gallon. Would that beer be brewed from the same materials as the one I have just mentioned?—I am sure I could not tell you without I was at the brewery. I could refer and let you know, and should be very pleased to do so.

9329. Inasmuch as it was sent at the same time, have you reason to believe the materials are very different? It would be probably from the same malt?—I do not think it would be very much different.

9330. It would be from the same malt, but probably in different proportion?—We make our own malts, and the proportions would vary somewhat.

9331. There are two independent results, you see. The beer you have mentioned of the 10th February, which was found to contain by the Inland Revenue chemists 1-80th, has also been subsequently re-analysed, and the duplicate is given as 1-100th. There is a discrepancy between 1-80th and 1-100th. Those are discrepancies I think you will admit of an order which may occur; 1-70th, 1-80th, to 1-100th are all magnitudes of very much the same order?—Yes.

9332. A sample of beer brewed by you on the 24th December, 1901, would be brewed from malt which probably was made by the use of gas coke?—Some portion of it; not all of it.

9333. Can you tell me relatively what proportion would be made from gas coke? I have details from your returns of the actual amount of malt employed; probably some of it would be made from English barley and some from foreign barley?—Yes, some from Yorkshire barley and some from foreign.

9334. But it would be all heated by the same fuel?—Yes; it was in our own kilns.

9335. You say some of it would be made by the use of gas coke?—Some portion of it.

9336. A large portion of it?—Not a large portion.

9337. What would be the other fuel used?—Anthracite.

9338. That beer was a gravity of 1045. Would that in your judgment be a stronger beer or not than this one sent to Mr. Hehner?—I am sorry I cannot answer that question. I have no particulars with me.

9339. That was reported to contain 1-50th grain per gallon. Do you think that is out of the question?—I do.

9340. Although it was made partially from malt made with gas coke?—Probably another analyst analysing the same beer would put it 1-200th or 1-150th.

9341. But you have no other reason to suppose that the result is inaccurate? Why do you say that it is out of the question that it contains the amount of 1-50th of a grain?—We have had so many varied reports. We never get two alike.

9342. The "Brown Cow" is an inn which you supply?—Yes.

* I find this was not brewed with the same malt.

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9343. Is it a tied house?—Yes, the "Brown Cow," Burnley Road, Halifax.

9344. A sample of beer taken by one of our officers from that house contained 1-30th of a grain per gallon. He was unable to ascertain when that beer was brewed or what materials were employed. In the same way do you think that is a quantity which could not by any possibility be in?—I think it is a grave mistake on someone's part. I do not think they obtained that percentage. I trust all these figures are not going out to the public, gentlemen?

9345. (*Sir William Church.*) You introduced them yourself, not the Commission. You introduced them by saying you had an analysis in which there was 1-80th of a grain and the other 1-500th, and out of that it is necessary to go into the analyses?—I did introduce the figures, but I certainly introduced them in the interest of the brewers, that we might have a better system of analysis than we have, when we have such conflicting evidence as I have brought before you to-day.

9346. That is the very point we are trying to bring about ourselves, and it is very valuable we should know all about it. Here there is not conflicting evidence. You do not seem to have had these beers analysed which you are now being asked about. There is only one analysis?—Some of those reports are last year's, 1901, not this year's.

9347. But in 1901 you knew there was danger of beer being contaminated by arsenic?—We have taken every precaution since that date. There was no report of any arsenic in our district. It was in Lancashire.

Use of gas coke malt before outbreak.

9348. Probably most of your beers which went out before Christmas time were brewed with malt made with gas coke in the preceding year?—Yes, and anthracite. They were mixed.

9349. You used nothing but gas coke at all up to 20th February, 1901?—No, we had been only malting then one season; we used nothing but coke the first season. Since then we have used anthracite.

9350. So that a great portion of the beer sent out in 1901 would have been made by gas coke malt?—Yes.

9351. I rather gathered from what you have said to Lord Kelvin that you think brushing the malt is a very great safeguard?—I do.

9352. But you have never determined the difference between unbrushed malt and brushed malt so far as the percentage of arsenic present is concerned?—No, I do not think we have.

Effect of brushing.

9353. Therefore it is a perfect assumption of yours that your brushing cleans the malt?—No, it is not an assumption. I have heard of other brewers doing it, and they have found a great benefit in brushing it.

9354. But it would be brushed long before there was any knowledge of arsenic being liable to be in it?—Not so much as it is now.

9355. That I grant you. But you do not know of your own knowledge that your malt was more highly contaminated before it was brushed than afterwards?—We have found by paying special attention to the brushing that on analysis the malt has been much freer from any objectionable arsenical matter.

9356. It has been a good sample, but you do not seem to have had the unbrushed malt analysed?—No, I cannot say we have.

9357. (*Chairman.*) Would it not be a good thing to have the malt examined at different stages, one stage being the end of the kilning process, before brushing, and then a sample of the same malt after brushing, which would show how much arsenic is taken out by the brushing?——

Construction of his malt kilns.

9358. (*Sir William Church.*) You say that you have lately put up a large kiln for 120 quarters with improvements. To what end are those improvements directed, with regard to the admission of hot air, or what?—We have all the latest improvements in the machinery for dressing and cleaning both the barley and the malt.

9359. Not any new plan of passing the hot air through?—No.

9360. (*Chairman.*) Have you any experience of kilns in which the fumes from the furnace do not pass through the malt?—No.

9361. In all your kilns the fumes of the furnace do pass through the malt?—Yes.

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9362. (*Dr. Whitelegge.*) In your new kiln is there more than one floor?—Only one floor in the kiln itself.

9363. You have a dust chamber?—Yes.

9364. Did you hear Mr. Thompson's evidence this morning?—I did not.

9365. There is a dust chamber below?—Yes.

9366. Is anything interposed between the fumes and the under surface of the drying floor?—There is a large disperser at the top.

9367. Against which the fumes must strike before they go upwards?—Yes.

9368. I understand that up to a certain date you used gas coke?—Yes.

9369. After that time I understand that you substituted oven coke; is that right?—Yes.

9370. And afterwards you gave up both gas coke and oven coke, and had anthracite only?—That is so.

9371. Can you say at what date you ceased to use coke of any kind?—I could not remember. It would be about December or January last.

9372. So that for about ten months you have used oven coke?—Yes.

9373. As the result of your own experience, and of what you have learned, do you consider that gas coke is a proper fuel to be used in malting?—I should not like to say.

9374. You have given it up in your own works?—Yes. We have found the anthracite coal better.

9375. But better by reason of the exclusion of arsenic, I gather from your evidence?—Yes.

9376. If it is better by reason of exclusion of arsenic, does not it follow that gas coke is not the right fuel to use?—In some cases it might do.

9377. Do you think you would like to revert to the use of gas coke in your own works?—No.

9378. But you are not prepared to say it would be wrong in other works?—I should not.

9379. Are you acquainted with the report of the Manchester Brewers' Expert Committee?—I read it through at the time, and I have gone into it occasionally.

9380. When it was issued in May, 1901?—Yes.

9381. Do you remember one of the recommendations is that the maltster be required to give a guarantee to the brewer that he does not employ gas coke in the preparation of his malt"?—Yes.

9382. You noticed that at the time?—Yes.

9383. But you did not take any action upon it at that time?—No; we were only just commencing at that time.

9384. It is within your knowledge that other brewers in the Halifax district took action upon it?—It is not within my knowledge. I do not know what they did.

9385. Another recommendation is "That the malt culms be regularly tested for the presence of arsenic." Was that done?—No, I do not think it was.

9386. You brushed all your malt?—Yes.

9387. Would you say it is wrong to omit brushing as a matter of precaution?—Yes.

9388. In any case?—I should certainly recommend brushing it.

9389. Who is your chemist?—We have not a fixed chemist. Our borough analyst is the man we employ.

9390. You mention Mr. Hehner and Mr. Richardson. You have sent samples to different chemists at different times?—Yes.

9391. For examination for arsenic?—Yes, positively.

9392. Since when is that?—The last four months.

9393. Since the occurrence in Halifax?—Yes.

9394. But not before then?—No, not regularly. Perhaps twice a year.

9395. Do you propose to continue that practice?—Yes.

9396. Irrespective of any further mischief?—Certainly.

9397. Do you buy malt as well as make it?—No, very seldom indeed.

Guarantee should be obtained with purchased malt.

9398. It you were to buy malt, would you require a guarantee?—Certainly.

9399. Of what kind?—That it was free from arsenic.

9400. Would you require any guarantee as to the malt being prepared with a particular kind of fuel?—We should now, yes.

9401. And that would be right in future time?—Yes.

9402. Do you test the fuel that is used?—We have had it tested; tested about a month ago.

9403. You have had it tested on your own behalf?—Yes, by the borough analyst.

9404. Do you require a guarantee with that of freedom from arsenic?—Yes, we get them to certify that.

9405. Do you require a certificate that it has been picked over, or is it picked over at your works?—It is carefully gone through by our maltster.

9406. You told us of the discrepancy of analytical results in the case of beer; can you say anything about a similar discrepancy as regards malt? Have you submitted samples of malt to different analysts?—Yes; we have submitted a few, and I have the reports.

9407. A sample of the same bulk was sent to two different analysts?—Yes.

9408. And with discrepant results?—Yes.

9409. Would you expect in the heap of malt containing arsenic to find the arsenic equally diffused?—In some cases, yes. Do you mean in a bin of malt?

9410. Yes; take a bin of malt. I understand you have given a good deal of attention to this, and I am asking for information. Given a bin of malt or a heap of malt, would you expect arsenic to be equally diffused?—Yes.

9411. How does the danger arise of the arsenic getting into the malt?—I should think it arises from the fumes.

9412. And dust?—And dust.

Contamination of malt by kiln dust.

9413. Dust entering direct into it from the current of hot air and also dust falling into it that has been allowed to accumulate on a surface above, is not that so?—Yes.

9414. Would not dust falling into it tend to be very unequally diffused?—Yes, I should say it would.

9415. So that you would not always expect to find uniformity, would you?—It is very uncertain.

9416. But you have not made any observations in that direction?—No, I have not.

9417. (*Chairman.*) Is there any mixing of the malt in moving it; mixing it up with a shovel or anything else?—No, we keep the different qualities separate.

9418. (*Dr. Whitelegge.*) If dust falls in, it remains there, does it?—It is brushed before it leaves the malt kiln, and brushed again before it goes up to the brewery. We always rebrush it before it leaves the maltings.

9419. You told us that the sample that was sent to Mr. Richardson was identical with the one taken by the Excise officers. In what way did you hear the result of the analysis at Somerset House?—I had a letter from them, which I have laid before you.

(Sir William Hart-Dyke in the chair.)

Mr. A. Worsick.

Mr. A. Worsick, Maltster, of Elland, called; and Examined.

9420. (*Chairman.*) How many years have you been in the malting trade?—This is my twentieth year.

9421. You have been actively employed in the trade for twenty years?—That is so.

9422. Before these circumstances at Halifax you heard and read a good deal concerning the Manchester scare?—Yes.

9423. Upon reading the accounts in the newspapers of the proceedings of this Commission did you take greater precautions with regard to the fuel you used in your business to protect the malt from the danger of arsenic?—Yes.

9424. Can you tell us what special precautions you have taken? I am putting on one side for the moment

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what happened at Halifax?—The first intimation I had of it was in December, 1900. I, like most maltsters, was flattering myself we were all right; that it was the sugar which was wrong. According to the reports, beers on being analysed without any glucose and sugar were still found to be more or less contaminated. I then heard that malt had been tested, and was found to contain arsenic. I sent my samples off immediately, about the middle of December, 1900.

Precautions since 1900 epidemic.

9425. Where did you send them?—To Dr. Miller, of Manchester. He reported that they were not as clear as they ought to be. He said they were not right. I was very much surprised at this, and went to have a chat with him, and asked him what he considered would be the best fuel to use. At that time he could not tell me. He said he thought anthracite coal would be the best, and I immediately changed on to anthracite at that time. I dried a few kilns of malt with it, and I sent them to be tested. He reported they were pure. I also put in new machines; I had a machine at that time with beaters in it, a centrifugal "Baron," and I heard that brushes were much more effective; and I had the brushes attached to the beaters which rubbed the malt alongside of the screen. It certainly took out all the culms, and I had also aspirators attached to the machines which sucked out pretty well all the dust, took it away into a stive room, or dust room. Then I put a similar machine in. I still found on the second machine that I have more or less out, and I have a sample here of the different culms.

Anthracite substituted for gas coke.

Malt brushed, &c.

9426. Malt samples?—No, samples of the culms and the dust.

9427. This Manchester analyst, Dr. Miller, communicated to you that there was arsenic in these samples which you sent up?—Yes.

9428. And suggested to you that probably the presence of this arsenic arose from the fuel which you were using, and suggested that you should change the fuel you had been using and use anthracite?—That is so.

9429. Did he tell you that there was danger from using gas coke?—I do not think he did. I do not remember. He was still in doubt about it himself. It was a very early stage at that time. There was a great deal of uncertainty expressed as to which was the best. Many people thought coke was the best fuel. He could not really help me, but he said he thought anthracite would be the best, and it proved to be so in my case.

9430. Can you say yourself from personal experience that you think gas coke is undesirable for malting? As a general opinion: I do not wish to tie you down too closely?—I think it is.

9431. Do you think that opinion is largely held by maltsters in Yorkshire at this moment, that gas coke is not a good fuel for malting purposes, that it is more likely to contain arsenic than anthracite?—That is so.

9432. That is the general opinion in the Trade?—That is so.

9433. Can you show us any reports of analyses you have had made?—Yes.

9434. Can you quote one or two to the Commission, or do you wish to hand them in as evidence?—No, I do not.

9435. You would rather not?—Yes. I was asked to state what precautions I have been taking, and the analyst's papers I have here date back from December, 1900, up to the present time.

9436. Since December, 1900, you have been having constant analyses of your maltings?—Yes, the last is March 20th, 1902, but I have one at home that came this week, which I have not brought here. It is still the same report. He says, "March 20th: I have tested for arsenic the samples of malt brought from you today. The results are as under: Northowram is pure, and Elland is pure."

9437. Taking those analyses before you as a whole, what is the result of them as regards the presence of arsenic in any sample that you sent up?—I find them to come out fairly consistently pure since I have taken precautions of being careful in the selection of my fuel. I have been careful in selecting the anthracite because I found that to vary.

Care needed in selecting anthracite.

9438. You found even with the use of anthracite some care should be taken in regard to the coal used?—That is so.

9439. Do you think it should be picked over by hand or examined closely?—I instructed my foremen when they were taking in fresh loads of coal to look out for any of the pyrites, and now and then one has found a metal substance, and they have instructions to pick that out. It is very rarely we do come across it.

9440. But when found it should be picked out at once?—Yes.

9441. Do you wish the Commission to understand that since you have been more particular as to the use of your fuel and used anthracite carefully examined before use, that the analyses have shown a great improvement as regards the presence of arsenic?—That is so.

Precautions have reduced arsenic in malt.

9442. That is what you wish the Commission to understand?—Yes, and many of my customers of Lancashire both test the malt itself and submit it to other brewers' chemists for their testing. Most of my customers had Dr. Miller as their analyst; some have had Dr. Campbell Brown of Liverpool. The samples have come out all right.

9443. With regard to the brewers, your customers, have you had requests from them to give any guarantee as regards the malt you supply, or as to special treatment with regard to fuel?—Yes, I have sometimes. I had a customer in Salford at the time of the Manchester scare. They had no difficulty with their beers at that time, but at the same time they were very anxious about it, and they said that all malt would have to be guaranteed free from arsenic. The malt I sent I put on "guaranteed pure" across my invoices. Their results were I believe perfectly satisfactory.

9444. Have you made any effort to get a guarantee from the persons you buy fuel from?—I have asked them for it.

Guarantee of malting fuel unsatisfactory.

9445. Have you endeavoured to get anything like a guarantee as to freedom from pyrites?—They have sent me analysis of their coal, which is quite free from arsenic, as they state, but at the same time most of them are very chary about giving you a guarantee about freedom from arsenic. They know you are quite liable to have more or less in all coal.

9446. In each case, where possible, do you get a guarantee as to freedom?—No, I do not. Of course, knocking about myself, doing most of my own travelling, I come across many maltsters, and we have a chat with one another, and we have found out in that way a few collieries whose coal has proved itself to be very good. I have never asked them for a guarantee of purity at all. I have received their reports, and I think I have one or two here. There is a tender here, "I beg to thank you for your esteemed favour of the 25th, and I have much pleasure in handing you our price for best malting coal free from arsenic, as you will see from report of our analyst, copy of which we send you herewith." There is the analysis of the coal.

9447. You wish us to understand that if maltsters travelled about like yourself, and were careful as to the selection of the colliery, it would be more valuable than the paper guarantee?—Yes. It is very easy to say, "They are guaranteed free from arsenic"; but I do not see really what good that is to us. The thing that we must go by is the purity of our malt after being dried. I have found that the best way. I do not think much about their guarantees. They do not bind themselves in any way. The analysts tell me they can get hold of a piece of coal that is perfectly free, but it does not say the whole truck is free. In a huge piece of coal—and anthracite coal is in very large blocks, indeed—in breaking them down it is quite possible at times to come across a little of the pyrites. You might analyse several pieces of coal out of the same truck and find them pure, and still find one piece with the pyrites which would give arsenic. At the same time there are no doubt seams which are really very free from sulphur, and where sulphur is, I believe arsenic is.

9448. Were you using in your malting process in August last gas coke, or last year at all?—No.

9449. You were not using any gas coke in 1901?—No, not at all.

9450. Only anthracite?—That is so.

9451. But during the previous season did you use any gas coke?—I used a very little gas coke, because the season does not commence until the end of September or the beginning of October, and I changed in December absolutely to coal. For two months I had a blend in the 1900-1901 season.

Some gas coke used in 1900-1 season.

9452. You might have been applying in August last malt which had been dried possibly by gas coke?—I should think it was very unlikely at that time. That is something like eight or nine months afterwards.

9453. It has been suggested by Mr. Hammond Smith that some malts supplied by you to Alderson's Brewery from your town malting in August last might have been made over gas coke?—I should think not.

9454. You think it is not possible?—No. The principal coke I was using there before I changed over to anthracite was made at a pit just above the kiln, and the coke I had been using was principally from that colliery, which has a reputation of being very free from sulphur.

9455. (*Sir William Church.*) That would be oven coke?—That is so.

9456. (*Chairman.*) Not gas coke at all?—That would be oven coke. But you asked me if I had used any gas coke, and I said "Yes." I had about two or three loads of gas coke, but the principal fuel was this oven coke.

9457. You believe in the brushing process as a valuable process?—It takes all the loose material from the corn, and polishes it up. Sometimes in corns you will find a bit of husk loose, what we call beeswing. It brushes all that off; takes that away, and leaves you a clean malt.

9458. The idea being if there is any mischief occurring the fumes will attach to these portions, and that is where arsenious oxide is likely to be, and that by the brushing process you do away with the danger?—That is so.

9459. I suppose you have never taken the trouble to test any malt for arsenic before the brushing process to see the distinction between the two?—I have not; not to give you an approximate amount. But I have done this. I have had samples taken out of a heap and sent off for the test; just taken out of the heap, and then I have had samples put through the brushers out of the same heap, and sent that; and the analyst told me that the brushed malt came out very well indeed—"a shade purer, at any rate, than the other," that is how Dr. Miller put it.

9460. That is to say pure as regards the presence of arsenic?—That is so.

9461. (*Dr. Whitelegge.*) Did he say a shade purer?—Yes.*

9462. (*Chairman.*) There was a difference at all events in favour of the brushing, and his expression was "a shade purer?"—Yes.

9463. (*Dr. Hammond Smith.*) Perhaps you can clear up this suggestion of mine. Some malt was supplied by you to Alderson's Brewery in August last. I think that was your statement. I have it here written down, that you were frequently supplying Alderson's, and some of that went straight from the Northowram malting to Alderson's?—That is so.

9464. Some of the malt went from the Northowram malting in August last?—Yes.

9465. To Alderson's?—Yes.

9466. That at the date in August the malt sent might probably have been some of the older malt made by you before you changed to anthracite, malt stored up at your maltings?—I do not think so.

9467. That is what I understood from you?—I should not think so. I could not tell you from memory.

9468. But you could hardly tell in any other way than from memory, because your malt at Northowram is stacked in great heaps against the wall in the malt room?—Yes. But it is a kiln where I am working regularly taking the malt away.

9469. At what date did you change the fuel at Northowram?—About 20th December, 1900.

9470. That is exactly the date I have in my hands. I rather gathered from your foreman that in August, 1901, there would have been some stock of malt made before that date?—I could not tell you.

* I find on reference that Dr. Miller stated the brushed malt was a distinct improvement on the unbrushed, and not as stated to the Commission.

9471. (*Sir William Church.*) You have told us that the anthracite you received is in large blocks, and that you have to break it up before putting it on the furnaces?—That is so.

Exclusion of pyrites by maltster.

9472. Could you, as a practical man, tell me whether it would increase the labour that your stokers should pick out any lumps which look as if they contained pyrites. They can easily learn to recognise them, cannot they?—Quite easily. It is a metallic substance. It is easily detected as different from the coal.

9473. I suppose you have given those instructions to them?—That is so.

9474. Do you find often lumps of pyrites?—Very rarely indeed, but just at isolated times.

9475. When maltsters are preparing their anthracite for putting upon the furnaces, it would be, comparatively speaking, an easy thing to eliminate most of the pyrites accidentally present?—That is so.

9476. (*Dr. Whitelegge.*) Do you use any lime?—I have used a little.

9477. With the view of checking the dissemination of arsenic?—Yes.

Construction of his kilns

9478. You attribute the freedom of the malt from arsenic to the precautions you take in the matter of fuel. You do not attribute anything, do you, to any peculiar construction of your kilns?—No, I do not. I have tiled floors, and I clean out the chamber regularly where what we call the rock comes—that is, the dust which drops through the perforations in the tiles. They drop on to the arches below. The drying kiln is formed with arches coming down to the fires, and the loose culm more or less drops down through these holes, and we have that to clear away. It is a dust of no use for feeding or anything of that sort. We call it rubbish.*

9479. Have you more than one floor?—No.

and their cleansing.

9480. Do you clear out the kilns?—Yes.

9481. Do you remove the dust from the walls?—Yes.

9482. Are there any girders, or beams, or rafters overhead in the drying chamber?—Yes.

9483. Are they cleared of dust at short intervals?—Yes; all brushed down and the place is whitewashed each year.

Guarantees not usually given with malt.

9484. When you send out malt to customers do you send them any assurance as a matter of routine that it is free from arsenic?—No; they take my word for it now pretty well.

9485. But you give them your word for it?—I know this, that if they found arsenic in it they would not have it.

9486. But does the invoice contain any statement as to freedom from arsenic?—I think I have two customers to whom I simply put "guaranteed pure" on the invoice.

9487. Otherwise you rely on a general understanding without any expression on the invoice or otherwise?—That is so. I know my customers personally. It has been one of the topics of conversation for about fifteen months talking the business over, that chiefly—and the business being my own—I have been making an effort to get my malt as pure as ever I can. I have spared no expense in the price of coal. I have given up to 35s. 3d. a ton delivered to my place, and I have given as low as 26s. I have found them, sticking to about two collieries, to come out very satisfactory.

No malt now sent out unbrushed.

9488. Under no circumstances do you send out malt unbrushed, do you?—No, not now. We do not send anything out now except what is brushed.

9489. Is that by way of additional precaution against arsenic?—Yes.

9490. Or for other reasons?—No. It is merely to try and get the malt as clean as possible and get all foreign matter off the husk, and get the culm away.

(*Chairman.*) The Commission has appreciated very much the early precautions you took to ensure immunity from danger.

* I do not, of course, wish to convey the idea that my malts "are free from arsenic," but to say they are reported "pure" by Dr. Miller, who has rather a strict standard of commercial purity.

TWENTY-SECOND DAY

Thursday, 17th April 1902.

AT WESTMINSTER PALACE HOTEL.

PRESENT:

The Right Hon. Sir WILLIAM HART-DYKE (*Chairman*).

Sir WILLIAM CHURCH.
Professor THORPE.
Dr. WHITELEGGE.

Dr. BUCHANAN (*Secretary*).

Mr. J. F. Woodyatt.

Mr. JOHN FREDERICK WOODYATT (of Halifax), called; and Examined.

Mr. J. F. Woodyatt.

17 April 1902.

17 April 1902.

Halifax outbreak.

9491. (*Chairman.*) You have been for some time visiting surgeon to the Halifax Poor Law Infirmary?—I am the principal medical officer at the Halifax Union Poor Law Hospital. It is a new institution, which was opened in October last, and that is when I received my appointment.

9492. How long have you been in the profession?—I was qualified in 1888.

Cases in Halifax infirmary in 1900.

9493. Previous to these events in Halifax, concerning which you have come to give evidence, have you taken personally any interest in the cases which occurred in Manchester with regard to arsenical poisoning?—I have. About eighteen months ago we had several cases of chronic arsenic poisoning at the old Workhouse Infirmary, which was then under the charge of Dr. Dolan. These cases were on that occasion diagnosed, and he asked me to see them. I was then a kind of deputy medical officer to him, and when he was away I took charge of the hospital. I saw the cases then, and was very interested in them.

9494. Did you form any judgment as the result of your investigation?—The cases were seen by many medical men, amongst whom were the Medical Officer of Health, and I do not think anyone had any doubts that they were arsenical cases. I myself was certainly convinced that they were chronic arsenical poisoning cases. I have the names of those cases which were given to me a little while before I came up by Dr. Dolan. He says here: "Cases of arsenical poisoning from the workhouse, some of which were seen by Dr. Neech, Medical Officer of Health, Dr. West Symes, Mr. Woodyatt, and others." Then he goes on to give the names, and at the end he says: "These cases were reported to the Halifax Board of Guardians at the time."

9495. Have you a copy of that report?—I have only the names in Dr. Dolan's handwriting. I do not think at the old hospital any very careful records were kept of cases. I am afraid this is all we have.

9496. How many cases were there?—There were eight. He puts eight cases down here.

9497. Had you personally examined each one of those eight cases?—I saw them. I cannot say that I carefully examined each case. I did examine them, of course, and I was very interested because there was one man who had very marked diaphragmatic paralysis.

9498. And it was partly from your own observation and partly from what you heard of others that you formed an opinion?—On that occasion, quite so.

9499. It was partly hearsay evidence and partly general observation?—My attention was drawn to it first by Dr. Dolan, and then I formed my own opinion afterwards.

9500. With regard to the cases which have now been reported to the Commission, that would be later, would it not?—Yes.

Cases during outbreak, 1902.

9501. With regard to the nine cases reported from the new Halifax Infirmary, how many of those nine cases were actually under your care and supervision?—All but three. I saw them all, of course, but all but three were actually under my care. The staff at our hospital is a responsible medical officer (myself), an assistant medical officer, who is my colleague, and a resident medical officer, who is the house surgeon practically.

9502. How often would the resident medical officer visit the infirmary?—He lives in the hospital. In his rules he is supposed to visit night and morning.

9503. You wish the Commission to understand that in six, at all events, out of these nine cases you had intimate knowledge of each symptom, and an intimate knowledge of the cases?—I had an intimate knowledge of all the cases, because I was very interested, and I visited the cases of my colleague, Mr. Shaw.

9504. In one or two of these cases there was a very marked difference of opinion, was there not, between yourself and other medical men in the district in regard to the diagnosis?—With regard to some of them, yes.

9505. In regard to how many?—If you will kindly allow me I will go through the cases. I have the hospital bed tickets with me, and I can explain that difference. The day the hospital was opened, October 8th, the first case was admitted in the ordinary way in the receiving room, and I received her when she came to the ward. With regard to cases No. 1 and No. 2, I may say in passing they were both diagnosed by myself in the first instance, and that no one suspected arsenical poisoning but myself. I not only suspected it, but I put it down in writing on the bed ticket at the time. I was sure they were arsenical cases.

9506. Can you mention the names of those two patients?—Wilkinson, who was admitted on October 8th, was diagnosed then by myself as peripheral neuritis, arsenic. The patient was unable to walk; had no tendon reflexes, and much pigmentation of skin. Those were my notes taken at the time of admission and examination. The other was Shearing. The history I have down was "Ill many years every winter with pain in the back or joints; worked up to six weeks ago; condition on admission: patient very anæmic, œdema of face, had trace of albumen in the urine." That was not dignosed by anyone when he came into hospital; it was thought to be a case of chronic Bright's disease, but after he had been in a few weeks I was not satisfied with the diagnosis, and carefully examined the patient and diagnosed him as a well-marked case of arsenical poisoning. That is case No. 2. Case No. 3 came in from her own home with marked pigmentation and branny desquamation.

Arsenical poisoning diagnosed certain cas

9507. (*Sir William Church.*) Is that Louisa Lowrie?—Yes. This I took to be characteristic of arsenic; not only the pigmentation but the branny desquamation. There were no other marked symptoms in Lowrie. She gave a history certainly not of being a beer drinker, but I believe her friends said she was.

9508. (*Chairman.*) What was your conclusion in regard to this case?—I considered it was chronic arsenical poisoning. I think she did not look "beery," if you understand the expression. I do not think she was an alcoholic. I think it is just possible she might have got it from some other source, but I cannot say. The other two, Wilkinson and Shearing, were undoubtedly beer drinkers. Lowrie certainly said she was

not, but her neighbours—who may or may not be reliable—said she was. She certainly had not that appearance. The next case, case No. 4, was brought in at night in an extremely filthy condition. He was a man of 81 years of age, and he died under four days—he died on the 8th.

9509. What was his name?—McNulty.

9510. (*Sir William Church.*) His age was given to me as 84?—I have it 81. The patient was in that filthy dirty state, and evidently moribund, that the symptoms one has I am afraid are rather more general than otherwise. I saw him after admission, and saw him on other occasions before he died, and I certainly came to the conclusion that he was not dying of arsenical poisoning. I did not consider the pigmentation that he was supposed to have, according to the house surgeon, was arsenical. His skin was very dirty and had scabby, scaly sort of sores that one gets in a man in a filthy condition. I am told he had slept about the country, in and out of houses for many years. From that I do not consider that any slight change in the colour, which might be a matter of dispute between two medical men, justified one in calling him an arsenical case. I may say he was drunk when he came in. He had been going about and doing his ordinary hawking. He was a hawker, and the history to my mind was not that which one got in the other cases, and certainly his condition was not the condition I have seen in the people before.

9511. (*Chairman.*) Is there any other case you can place before the Commission where there was a distinction or difference of opinion of that kind between you?—The next case is Lawrance Whalan, who was an old feeble man, very anæmic, and developed keratosis soon after admission to the hospital. I considered the case to be one of pernicious anæmia. He died on March 24th, a little over two months after being admitted to hospital. He never improved, but gradually, as one sees in pernicious anæmia, went out, and no treatment seemed to have any effect upon him at all. He was given the various drugs we give for pernicious anæmia except arsenic, because there was arsenical poisoning. He was an arsenical case, and therefore I did not give him arsenic. Unfortunately I was not able to get a post-mortem in this case. I tried very hard, but the people were Irish, and the Irish are rather averse to post-mortem examinations, so that I was not able to get it.

9512. Who signed the death certificate?—I did.

9513. And when you signed the certificate you had no reason to suspect this was a case of arsenical poisoning?—That is so.

9514. (*Sir William Church.*) Six were under your personal care?—Yes. But I saw them all, and examined them carefully. To my mind there is no difference between one set and the other. I have given you the cases in the order of admission to the hospital.

9515. (*Chairman.*) Before these occurrences at Manchester which led to the appointment of this Commission, had you, as a medical man, any suspicion whatever with regard to even the possibility of poisoning by arsenic in beer?—I had not, but I have formed a conclusion since the Commission sat, and since the two outbreaks of these cases in Halifax.

9516. At first it was the Manchester outbreak that brought to your mind the possibility?—That is so.

9517. I suppose you never considered such a question before, and it was never brought under your notice as a medical man?—No. I often gave arsenic to patients. I have been in various hospitals for over six years as resident.

9518. It is not an uncommon practice, is it?—The only symptoms I could say I have seen are vomiting, and the watering of the eyes, and then one generally stopped or decreased the dose, and the patient got all right.

9519. During the cases of arsenical poisoning in Manchester and the surrounding district did you see any of those cases?—No, not in Manchester. At the time the cases were in Halifax, and I saw them there, I received from Dr. Reynolds, who was formerly resident with me at the Manchester Royal Infirmary, his brochure, which was very descriptive, and contained numerous copies of photographs, which I, of course, studied.

9520. Will you kindly tell the Commission when and where you first saw a patient suspected to be suffering from arsenical poisoning due to beer?—At the end of September, 1900, at the old Workhouse Infirmary, Halifax. It was the winter of 1900, late in the year of 1900.

9521. But some while before these occurrences which you have mentioned to us in the Infirmary?—Yes.

Dr. Woodyatt's examination of cases at Infirmary.

9522. (*Sir William Church.*) Would you kindly tell the Commission what are your exact duties as visiting officer to the Halifax Infirmary?—I am the responsible Medical Officer appointed by the Guardians, and approved by the Local Government Board. I am responsible really for everything in the institution. My definite duties are not drawn up. It has been a new appointment, and the guardians somewhat hesitated to define one's duties very definitely, and have not yet done so. But I may say that I have been to the hospital a great deal, and I very seldom have missed a day. Some days I have been there twice. Of course, I am a medical practitioner in the town now, and this is just an appointment which I hold. I think I may tell you that I have been a hospital resident for a number of years, and I take a great interest in hospital work and administration, and I think that is what has got me this responsible appointment.

9523. You are responsible for all the patients in the Infirmary?—When put in that way, yes. I have two assistants. Their title, which is in the Local Government Board Order, is Assistant Medical Officer, and the third one is the Resident Assistant Medical Officer. They are, therefore, practically under me, and I am responsible for all that takes place in the institution.

9524. Would you kindly tell us what is your routine when you pay a visit?—I go in the morning, and I invariably see all new cases that are admitted. I examine them, and prescribe for them, and very often diagnose them, or, if they have been already diagnosed, I either confirm or alter that diagnosis.

9525. You examine all the new patients yourself personally?—Well, there are certain cases that have been allotted to the Assistant Medical Officer. I have done that myself to relieve myself of responsibility. Our institution is one of three hundred people almost, and that is a large number. We have not many daily admissions. There are principally old chronic cases that you get in other workhouse hospitals.

9526. What we rather wanted to know was whether you, as a matter of routine, examine all patients yourself, or only examine those your Assistant Medical Officer or Resident Officer draws your attention to?—I may say practically I have examined all male patients who have been admitted to the new hospital since it was opened in October last, and those female patients that my attention has been drawn to by the Assistant or Resident Assistant Medical Officers.

9527. Do you prescribe for them as well as diagnose the case?—Very often.

9528. When you diagnose the case, do you write the diagnosis upon the board, or is that left to a later date?—I generally like it done at the time, and if it is not done already I very often put it down in my own handwriting, which you will see if you care to see my bed tickets here.

9529. Do you consider you have any other duties besides those in the infirmary?—No public appointment.

9530. Visiting the patients in the wards completes your duty as far as the Poor Law hospital is concerned?—I attend the Infirmary Committee meetings once a week; not that it is necessary, but I go just to report, and to see what is going on in the house. Except for that I have no clerical duties beyond the medical work.

9531. What do you include in the medical work?—Examining, diagnosing, and treating cases and discharging patients.

9532. Do you generally attend in the post-mortem room or not?—Very often.

9533. Is that part of your duty, or do you go there yourself?—I go down, and sometimes make the post-mortem myself, and sometimes the house surgeon does; or we do it together. I have attended most post-mortems that have taken place since the hospital opened.

9534. You consider that that is part of your duty almost?—Quite so.

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9535. With regard to the certificates, of those who die in the hospital, do you usually sign the death certificate or not?—I do not.

Does not usually certify deaths, but did in Whalan's case.

9536. I think you did sign the death certificate of Whalan?—I did; and if you will allow me I will give you my reason for doing so. At two former inquests which were held there was a difference of opinion between me and the house surgeon.

9537. I do not think I need go into that, but as a matter of fact you did sign the death certificate; there were reasons that made you sign it, but that was an unusual course?—It was an unusual course, yes.

Wilkinson.

9538. I should like you to kindly give the Commission some information about some of these cases. The first case in which you recognised arsenical poisoning was Mary Wilkinson?—Yes.

9539. She got well?—Well, she is in hospital now; she is convalescent.

9540. But at all events she is getting well?—Yes.

Shearing.

9541. And George Shearing?—He is now in the hospital. I examined him on Monday the last time, and I consider that he is making practically no progress. His paralysis has passed off to a very great extent; he can just totter with help.

9542. But with regard to those two cases, you have no doubt yourself that they are arsenical?—Absolutely none.

Lowrie.

9543. Louisa Lowrie?—I have no doubt in my own mind.

9544. She is still in the hospital?—She is still in the hospital.

McNulty.

9545. I think that McNulty was the fourth?—That is so.

9546. I rather gather from what I hear that you considered him during life to be an arsenical case?—No, I did not. I considered he was an old bronchitic; that he had an acute attack on top of his chronic condition, and that he died from that cause.

9547. The pigmentation on McNulty you considered was due to dirt?—I did.

9548. Was there not something peculiar about the pigmentation if it was due to dirt?—I do not think so. I carefully examined him both during life, and in the post-mortem room, and I could not see it.

9549. Did you notice anything about the soles of his feet?—I did. I did not think his feet were more scaly than one usually finds in tramps. In people of that class, if you examine their feet you will always find the skin thickened and scaly to a certain extent.

9550. You think he had no foot drop?—I do not think he had. I may tell you I did not take his reflexes, because the house surgeon told me that he had tried them, and they were absent. Seeing his condition I did not feel justified in setting him up, and carefully testing for the tendon reflex. I took it for granted he had none.

9551. He had a good deal of puffiness in the face, and running from the nose and eyes?—I do not think so. That is just a matter of opinion, where I think medical men may disagree. In an old man in that condition one man might think there was some running, while another man might think there was not

9552. But arsenic was found in his urine?—No, not.

9553. Arsenic was found at the post-mortem investigation of the liver?—That is so.

9554. On what ground do you exclude the possibility of arsenic having played a part in producing the man's condition?—I do not exclude it. I gave my opinion before any chemical examination. I gave my opinion from the clinical examination, and from the post-mortem examination.

9555. What I want to put to you is the fact that the man having bronchitis does not exclude his suffering from chronic arsenical poisoning, does it?—No. But he had dilated tubes in the post-mortem room; the tubes were very evidently dilated. They stood up out of the lung tissue, and were unnaturally dilated. That proved to me that the man had been suffering from bronchitis for many years. I do not think tubes get into that condition quickly. It must take a considerable time. That was what convinced me.

9556. But supposing he had been a sufferer from chronic bronchitis for many years, he might also get arsenical poisoning?—I cannot say he had not been drinking beer that contained arsenic; I do not wish to say that for a moment, but the symptoms I have seen in other cases were not evident in this man. That is my argument. I am not surprised that arsenic was found in his tissues seeing he was a heavy beer drinker.

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9557. You thought his general appearance differed very considerably from those cases which did not die?—That is so.

9558. Still, considering that a considerable amount of arsenic was found in his viscera, that is rather an assumption?—Well, I remember Mr. Allen at the inquest said that there was not more than 1-400th of a grain in the whole of the tissue he examined.

9559. But the whole tissues he examined were only four ounces?—I think they were a little more than that. I have not got the exact amount of tissues he had; he did not say how little it might have been. It might have been a very small trace as far as I could gather. He said "not more than 1-400th of a grain." He did not say it was 1-400th of a grain.

9560. The statement made in this report, which you have seen, "I may note that, taking the quantity of arsenic found in four ounces of liver at 1-700th of a grain, and the weight of the liver as 53 ounces, there would be about one-sixteenth of a grain in the whole liver. This result is not dissimilar to those obtained by Dr. Stevenson and Dr. Dixon Mann in fatal cases in Manchester in 1900"?—I have only the information the analyst gave at the coroner's inquest, and that is what he told the coroner. I remember distinctly his words, because it rather impressed me that a chemist should say "not more than." He also said at the end of his evidence, something which I did not attach much importance to, that the amount was quite insignificant and did not mean anything. I will not admit it was of no importance, because I think it was. He did say "not more than," I am quite convinced.

9561. You had no doubt that Thomas Lee during life was suffering from arsenical poisoning, had you?—None whatever. He was certainly the most marked pigmentation case I have seen. I have had his photograph taken, which perhaps you have already seen, as I gave Dr. Hammond Smith a copy.

9562. His death was due, in your opinion, to what?—To acute croupous pneumonia.

Lee.

9563. I suppose you would consider in Thomas Lee's case that his chronic arsenical poisoning was a contributory fact to his death?—I will tell you what evidence I gave before the coroner, and perhaps that would be the best way to explain it. I described Lee as a well marked case of arsenical poisoning, and I produced this photograph to the coroner, and he showed it to the jury. I described his condition, and then I described the post-mortem, and what I found in the post-mortem room. If you wish it I will read the post-mortem report, although it is rather lengthy.

Statement to coroner as to cause of Lee's death.

9564. I do not think we need to have that?—With regard to my opinion as to the cause of death, I was asked very definitely by the coroner, and I said I was of opinion that Lee had died of acute croupous pneumonia, but what part, if any, had been caused by the arsenic the patient had undoubtedly taken I was not prepared to say. Those were the exact words I gave to the coroner.

9565. Could not you say that of almost all these cases?—I think if Lee had died without his acute croupous pneumonia, which, I take it, is the condition caused by the pneumo-coccus, if he had died with congestion of the lungs with that amount of pigmentation, I would not have hesitated in saying that arsenic had caused his death; but Lee was a man who had various other diseases, which were only found out on the post-mortem table. He had a stricture of the urethra, and a hypertrophied bladder. He had granular kidneys, a hypertrophied heart, and aortic disease, and acute croupous pneumonia.

9566. But does not that only show that a patient suffering from arsenical poisoning may die of other causes, whether acute pneumonia or septic poisoning, or whatever it may be?—Of course the man died, and he was an arsenical case, but what part the arsenic played I really cannot say. Lee improved considerably. When he came in he was very shaky, and had bronchitis; he had a very husky voice. His bronchitis cleared up, and he was taking the ordinary hospi-

tal diet, the diet on which we put convalescents and ordinary surgical cases. It was not a special diet we give to invalids. He was going to the lavatory, and his condition altogether was not bad. He improved; and his bronchitis went away. I had him brought to the theatre and the photograph was taken. The man did not look ill. He had very marked pigmentation. Then at a certain date (I have the chart here), about the 23rd of January, the temperature commenced to go up.

9567. The first week he was in hospital his temperature was normal or subnormal, and during the second week it gradually rose, and during the third week it became irregular, and at the end of the third week he died?—Yes, that is practically so. I take it that this rise of temperature was due to the pneumonia he had.

9568. Do you know at what time it was Dr. Reynolds saw him?—On the 21st January.

9569. I think he died on the 5th February?—Yes.

9570. Do you know what Dr. Reynolds' opinion of him was when he saw him?—I have Dr. Reynolds's letter here which he wrote after he had got home. Dr. Reynolds visited the hospital when, unfortunately, neither the house surgeon nor I were present, but he wrote the letter directly he got home, and this is what he says: "The male patients, Lee and Shearing, are well marked cases of arsenical poisoning of comparatively recent origin—that is to say, four months—and the woman Lowrie is also well marked, but possibly of an older date. I am not at all certain of Marsden, but he may be one." That is the report Dr. Reynolds sent after he returned home.

9571. He told us that when he saw Lee he considered him a very grave case, and thought that he was going to die, and that would be before he became so very ill of pneumonia, would it not be?—Yes, before his temperature began to rise.

9572. Now, with regard to the fifth case on which there has been a good deal of difference of opinion—Whalan. You think that Dr. Reynolds did not see Whalan?—Of course, I only have the evidence of the nurse. I asked the nurse whether Dr. Reynolds had seen him, and she said he had not seen him, and he does not mention it in his letter he wrote directly afterwards. Therefore, I came to the conclusion that he had not seen him. If Dr. Reynolds said he did I am quite prepared to accept his word for it.

9573. We were led to believe Dr. Reynolds did see him, but you think there might be some confusion between Whalan and Marsden—That is my own opinion, I think he was thinking of Marsden when he gave his evidence.

9574. Did you see Whalan when he came in in the ordinary routine and examine him on the first day?—If I did not examine the first day I must have done so on the second. I make my visits fairly early in the morning, and go through all the wards as a rule.

9575. You have no note of what opinion you formed on the first time?—I formed a very definite opinion. I saw him and got him up and walked him about, and examined him carefully, and I formed the opinion that he had no pigmentation, that his reflexes were present, that he had no drop ankle, and there was no oedema; there were no symptoms except the anæmia that presented themselves on examination.

9576. Do you remember what he complained about chiefly?—Of weakness. I remember asking Whalan what was the matter, and he said he was terribly weak. If you put leading questions to some of these people I find you can get almost what you want, especially if they are worried a good deal. Our cases were examined by many doctors; all sorts of people used to come and see them, and put leading questions to them, until very often they sometimes say things they do not quite feel. I think sometimes the history is rather unsatisfactory.

9577. He made no complaints to you of a curious feeling of electricity about him?—No; I see that is put down on the bed ticket by the house-surgeon that he had a feeling of electricity all over him. But I do not remember him using the term to me.

9578. No tingling in his hands and feet?—When I put leading questions like that I can get any reply. I have done it since. I have asked people who have a certain amount of heart failure, who are bedridden perhaps, or are suffering from various conditions, whether their feet tingled, and a lot of people will tell you yes. I have tried to test what people of this class would say to leading questions.

9579. In your opinion it was an error of observation of the house-surgeon to say that his feet had been swollen and painful?—I will not say that. He had not got that when he came in. The house-surgeon does not say that. That is from asking him whether his feet were swollen, and he would say yes.

9580. There is another note which says there is well marked keratosis of the hands and feet?—That was not so on admission. He developed the well marked keratosis. Of course I admit he had very marked keratosis of the feet and a little of the hands. The feet were constantly shedding their thickened epithelium into the bed clothes.

9581. There was little or no pigmentation I think in this case?—I consider there was none. I see the house-surgeon puts his skin "slightly mottled." That is a matter of opinion where I think medical witnesses will very often differ.

9582. In pernicious anæmia, is there any change in the colour of the skin?—I am not aware that there is any pigmentation. They get exceedingly anæmic, as you are aware, and the anæmia does not pass off with treatment, as Whalan's did not.

9583. Are not you aware of any colouration which is not uncommon in pernicious anæmia?—I am not aware of it.

9584. You are not acquainted with what is called the "lemon tint," which so many of the cases of pernicious anæmia have?—He had that excessive pallor, and probably he had that, but I cannot say that I have ever heard the expression before

9585. Were the conjunctivæ of that colour, too?—They were exceedingly anæmic. I did examine the blood.

9586. There was nothing about his colour that at all attracted your attention?—Nothing, except the extreme pallor, and of course in a patient who is extremely pale you see a yellow case of the skin, as in old people, who are exceedingly pale. To see him you would think perhaps he had some malignant disease.

9587. What is the period of life when people are most apt to get pernicious anæmia?—I think he is rather old for it; I should say the common age is somewhat younger than Whalan's age.

9588. This man is 65?—That is the age given; I think it rather old for pernicious anæmia, but I do not consider his age excludes pernicious anæmia.

9589. No investigation I think was made of the blood of this man?—I examined his blood, and I may tell you I am not a practical pathologist. I have examined patients' blood very often, and I know there is a good deal written about it just now, and a lot of different cells described. The impression I got from the blood was that it was exceedingly pale when drawn. The red cells were exceedingly deficient, and they did not form rouleaux as the ordinary blood does.

9590. Did you examine the blood more than once?—Only on one occasion.

9591. How did you examine it?—Just in the ordinary way under the microscope.

9592. You did not use any reagents or staining?—None.

Dr. Mantle consulted regarding Whalan:

9593. Would you kindly tell the Commission under what circumstances Dr. Mantle was met? I do not quite understand how Dr. Mantle was brought in to this case?—There was a difference of opinion with regard to McNulty and one, which did not amount to much, in the man Lee. I did not think it was very dignified for two doctors to get up at an inquest, and one pronounce one opinion and another another, and I thought to avoid any repetition of the same thing I would get an independent medical opinion. I considered Dr. Mantle would give an independent opinion. He is the only medical man in Halifax who is a physician solely, and is the only member of the Royal College of Physicians, and I took it that his opinion would be of some value, and that is why I suggested Dr. Mantle should see him. I may say that Dr. Mantle's opinion was that the man had pernicious anæmia. I may tell you that the house surgeon thought he was dying of arsenical poisoning, and, seeing there was a difference of opinion, I would not take the responsibility. I thought I would get another opinion, and that was the

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opinion of Dr. Mantle, that he had pernicious anæmia. I went to the coroner and gave the coroner the full opinion, that one doctor said he was dying of arsenical poisoning——

after communication with brewers.

9594. I want to clear up Dr. Mantle first before we get to the coroner. Dr. Mantle came merely at your request?—At my request. I suggested Dr. Mantle; it was a professional visit, and he was paid.

9595. By you?—No, by the solicitor who was representing the brewers.

9596. Was it, therefore, not at their request as much as yours?—No, it was my own. I telephoned and told the solicitor that I thought it was in the interests of my own reputation.

9597. Had you communicated with the solicitor of the Brewers' Association before you called Dr. Mantle in?—I suggested a third party should see him; that was the first communication I had with them.

Evidence of arsenical poisoning in Whalan.

9598. You agree with the statement that this man Whalan had arsenic in his urine?—Yes. If you have evidence to prove he had arsenic I am quite willing to admit that, and I think the keratosis might or might not have been due to arsenic. I may say I have seen marked keratosis in old people who have a very dry skin, when they are thrown on to their back. I have often seen it. I have cases in hospital, one I am thinking of particularly now, a man who has very marked keratosis of his feet, who came in for disconnected semilunar cartilage a short time ago.

No post-mortem.

9599. You told us you greatly regretted you could not get a post-mortem examination of this man?—Yes.

9600. But, surely if you had stated to the coroner there were considerable doubts about this case, and you thought in the public interest there should have been a post-mortem, the coroner would not have objected to a post-mortem and an inquest?—I wanted a post-mortem for my own personal satisfaction, to prove, if possible, that there was no other organic disease that had not been diagnosed. That was my object in asking the friends for a post-mortem examination.

9601. Just now you rather told me you called Dr. Mantle in, in order that you might have no difficulty in signing the certificate as that of pernicious anæmia?—I called in Dr. Mantle so that there should be no difference of opinion at an inquest. I do not think it is dignified to the medical profession for doctors to differ, and their opinions to be published in the Press. That was the only reason why I called Dr. Mantle in. It was more for my own reputation than anything else

9602. Still the Brewers' Association paid Dr. Mantle his fee?—That is so. At least I understand they did; I told them I thought they ought to.

9603. And they were aware that you were calling Dr. Mantle in?—Yes.

9604. There would have been no difficulty in obtaining an inquest on Whalan, would there?—No, none whatever. If I had told the coroner I had wanted an inquest he would have said, "Certainly, have one by all means." I left it with him. I simply gave him the evidence, and he formed his own opinion.

9605. Therefore, so far, the result of these cases you have had in the infirmary at Halifax is that those who died did not die with arsenical poisoning, and those who lived you admit have had arsenical poisoning?—My argument is more that I will not say they have not had arsenical poisoning. My argument is that I did not consider they have died of it. That is my opinion.

Terms of death certificate.

9606. I want to press you a little upon that. How do you generally fill up a certificate of death?—The ordinary certificate says, I attended him in his last illness, and that I saw him last on a certain date, and that in my opinion he died of the following disease, and I put down the disease.

9607. In many death certificates at all events the immediate cause of death and the preceding condition of the person is mentioned?—Yes. I must say myself if the patient dies of anæmia I put it down. Take another disease, sometimes there are several predisposing causes. One does not put down everything on a certificate. I think that is the experience of most medical men; they save the registrar a little trouble perhaps and make it easier for him to get out his reports. They put down the immediate cause of death unless there is something very definite causing it. If I had a man with stricture, for instance, and surgical kidneys, I could put down surgical kidneys consequential to stricture of the urethra, but where there is a doubt that his pernicious anæmia was caused by arsenic one would in any case leave out the arsenic. If one had known that the arsenic had caused his pernicious anæmia one would have put it in.

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Diagnosis "pernicious anæmia"

9608. Do you know on what grounds Dr. Mantle came to the conclusion that the man was suffering from pernicious anæmia, did he examine the blood?—No.

9609. Did he recognise any peculiarity that patients with pernicious anæmia often show when he saw him? He made a very careful examination. He stripped Whalan; got him up——

9610. That would not help you, stripping him. Did he remark on the unusual thing of a man of 65 having it?—No, he did not, not to me. I simply got him there to form his opinion. He made his own examination; took his own history and notes, and formed his own opinion.

9611. You must have conversed with Dr. Mantle about it, and I wish to know what were the symptoms or physical signs that led him to form a definite opinion?—I told Dr. Mantle everything—that arsenic had been found in this man's urine, and I told him that I knew about him, and he examined him very carefully to find any cause. We all know that excessively anæmic people sometimes become so from organic disease, malignant disease, or something else.

9612. It is a very different thing to try to exclude the presence of a disease to the definite statement that it is present?—Pernicious anæmia is, I take it, a strange sort of thing. It is a thing that does not give rise to very many symptoms. There is not very much to show for it except the extreme pallor. The man on two occasions had epistaxis, which is, of course, a symptom in pernicious anæmia.

9613. So Dr. Mantle came to this conclusion without making any examination either microscopically of the blood or by the hæmoglobin test. Of course, there was no opportunity, as there was no coroner's inquest, of examining the viscera for those changes we find in pernicious anæmia?—That is so.

9614. He had no opportunity of seeing the man more than once, I think?—I think he only saw him once.

9615. After all, it comes to this, that the two cases that died, and which you did not think, for reasons you have given us, were suffering from arsenical poisoning, had evidence in their body of arsenic; in McNulty's case arsenic is found in the viscera, and in Whalan's case it is found in the urine?—That is so. When you come to say that I did not think they were arsenical, I may say that when I am told there is arsenic in the urine and a man has keratosis, I should say the arsenic is the cause of the keratosis.

although evidence of arsenical poisoning.

9616. But it is not contributory to his death?—Is not contributory to his death. That is my opinion.

9617. What led you to sign these certificates yourself and not leave it to the house surgeon to do so?—As I told you, we had differed very materially—at any rate in McNulty's case. There was very slight difference in Lee's case; we both admitted he was arsenical. As I said before, I think it is rather undignified that medical men's evidence should be put in the papers in this fashion, that one says one thing, and another another, and to save a repetition of that I called in a third opinion.

Did not desire an inquest.

9618. You think if the house surgeon had signed the certificate of Whalan that he was suffering from arsenical poisoning there would have been an inquest?—I think there would.

9619. And you were very anxious to know the condition of the man. You told us you were very anxious for a post-morten?—If there had been an inquest I should have been bound to give my opinions, and Dr. Hodgson on oath would have been bound to give his. I knew his opinions and he knew mine. As I have said before, I wished to avoid the difference of opinion coming before the public, as it would do if there had been an inquest. That was my only object in saving an inquest, absolutely. I selected Dr. Mantle simply for the reason I have told you, that he was a physician, that he has recently been made a member of the Royal College of Physicians, and I considered his opinion was perhaps the best one to take.

9620. But surely you came to your diagnosis of pernicious anæmia on rather slight grounds? There was none of that characteristic tint which is found in the cases; you made but one examination of the blood,

and that not using reagents; and you did not take into consideration that it is not common to get it in advanced life, and yet there was arsenic present in the man's urine and keratosis?—Well, of course, I formed my own opinion from various information which I had.

9621. And you took steps that there should be no inquest?—I did. I have given you my reasons for avoiding an inquest, and that was absolutely the only reason I had for not forcing an inquest, if you put it that way. The coroner had every information; he could have had an inquest if he liked.

9622. I suppose the brewers would not have liked another inquest?—I suppose really they would not. If I had asked them I have no doubt they would not have liked an inquest.

9623. You were in pretty constant communication with the brewers' solicitor?—No, I was not. I may say there was a certain medical man in the town, Dr. West Symes, who was watching the interest of the brewers, and he asked me as a professional man to keep him informed as to how many cases, and so forth, we had in the hospital, and he asked my permission to see the cases at the hospital, which I freely gave.

9624. (*Dr. Whitelegge.*) I understand Dr. Mantle formed the diagnosis of pernicious anæmia?—He did.

9625. Did he go further and pronounce any opinion as to the presence of any degree of arsenical poisoning?—When I told him that there was arsenic in the urine he admitted, as I did, of course, that when there is arsenic in the urine, if you have a man who is a beer drinker, and you have evidence that beer contains arsenic, therefore one comes to the conclusion that he had been drinking arsenical beer. Dr. Mantle admitted that, as I did.

9626. Did Dr. Mantle agree with you in recognising that though arsenic was present, still it was not a case of arsenical poisoning?—That is so.

9627. And he agreed with you that the arsenic was not the cause of the man's death?—That is so. I had a definite opinion, because I was very anxious that the difference of opinion should not come into the Press, because I did not think it was dignified to the profession.

9628. How long before Whalan died did Dr. Mantle see him?—Whalan came in on January 10th, and died on March 22nd. When I saw that the end was not very far distant I got his opinion then.

9629. With the view to a possible inquest?—Yes.

9630. Is an examination made in all the cases in the infirmary of the urine and hair for arsenic?—No.

9631. I mean of all the arsenical cases?—I cannot say. I am not a chemist, and I would not trust analyses made by myself.

9632. Steps are not taken as a matter of routine to confirm the diagnosis?—No: the Guardians have never paid for analyses. They will not do that.

9633. Has it been suggested to them?—No. I mentioned to our chairman, after the two first cases were admitted, and before McNulty came in, that we had some arsenical cases. I would like you to understand that I have been quite open about these things. I have reported them to medical men, and I was the first one to diagnose it. I mentioned it to our Chairman of the Board of Guardians. I think in the report Dr. Neech, the Medical Officer of Health, said the cases were not reported to him. That is so. Of course, I knew that Dr. Neech had seen arsenical cases more than twelve months previously, and I did not think it was necessary to draw his attention to them, or I would otherwise have done so. If they had been our first cases in Halifax I should probably have drawn the attention of the Medical Officer of Health to them.

9634. You referred to a list of cases in Dr. Dolan's experience?—Yes.

9635. On what occasion did those occur?—It was the time of the Manchester epidemic.

9636. Those were reported to the Guardians?—Dr. Dolan says so. I have his rough notes here if you would like to see them, and he says that.

9637. They were reported by Dr. Dolan?—That is so.

9638. Have you made any report to the Guardians on the recent cases?—I cannot say I have in a written report. I have brought it before them at their infirmary meetings. Very early on, before McNulty came in at all, when we had the first three, Wilkinson, Lowrie, and Shearing, I mentioned them to the chairman of the Board of Guardians, before there was any inquest or anything. You can see from that that I have been quite willing that the officials and the medical practitioners in the town should know. I read a paper before the Halifax Medical Society on chronic arsenical poisoning on the first Tuesday in February; I showed cases then, and I showed photographs, and there was considerable discussion on those cases and chronic arsenical poisoning generally.

Lowrie.

9639. You told us that in Lowrie's case, which you regard as one of chronic arsenical poisoning, it was possible that the arsenic came from some other source?—She told me very distinctly that she did not take any beer—practically no beer. She did not look "beery," or look a woman who drank, even when she came in. She looked anything but a woman of that type. Her friends, landlord, or neighbours, said she was drinking a good deal, but I think one ought to discount sometimes those reports. That is what made me think it possible that she might not get her arsenic from beer.

9640. But you do not suggest any alternative source for arsenic?—I do not. She was one of the patients I showed to the Society, and I do not think there was any member there, except Dr. Neech, the house surgeon, and myself, who thought it was arsenical. They doubted very much whether it was arsenical. But she was not quite so typical as when diagnosed by me. Then she had the branny desquamation, which had passed away, and she simply had a little pigmentation left.

9641. With that exception, do you regard all the recent cases in which arsenical poisoning has been established as due to beer?—I should say so. When I am told that beer contains arsenic, and of the former epidemics, and the Manchester epidemic, and other epidemics in Halifax, I am of opinion that these people who show symptoms of arsenical poisoning get it from beer. I have no personal experience of the analysis of beer. I am taking the evidence of analysts for that.

Symptoms of arsenical poisoning.

9642. (*Chairman.*) With regard to the symptoms of arsenical poisoning, what symptoms should you say would most clearly bring to your mind first of all in a patient that he or she was suffering from arsenical poisoning?—It depends upon the quantity. If we have a lot of arsenic, I think the first symptoms we should get would be sickness and diarrhœa, puffy eyes, watering eyes, and a certain amount of dropped foot, and early rashes of an erythematous nature, and the various rashes one gets. If there was very little, I think those symptoms are very masked, in fact hardly present at all, but you get the more remote symptoms shown, such as pigmentation, paralysis, and keratosis.

9643. Take pigmentation of the skin, for instance; does that occur in cases of patients without the presence of arsenic?—Yes.

9644. Do you know cases?—Oh, yes.

9645. Are cases of extensive pigmentation of the skin common among patients not suffering from arsenic?—No. I do not think any pigmentation like that shown in this photograph is due to anything but arsenic.

9646. You have never seen a case like that except caused by arsenical poisoning?—No. I have never seen such a case as that even in arsenical cases, none quite as dark as Lee.

9647. On this question of granting certificates of death, is it customary for medical men to state what the contributory cause of death is, or is it usual to place the disease that is the direct cause of death without saying death was hastened or contributed to by other causes?—It depends whether those other causes are of importance. Take, for instance, scarlet fever. If you have a case of scarlet fever nephritis, one would naturally put scarlet fever and nephritis following. One would put both causes, because one is convinced the scarlet fever is the original cause.

9648. In that case it would be a sequence of the original disease?—Yes. I should put it as I have done on former cases. Unless there is some special indication I do not often put more than one diagnosis down on the death certificate.

9649. (*Sir William Church.*) You make use of the usual official certificates of death?—Of course.

9650. Are there not two columns that may be filled up?—I believe there are three.

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9651. And you only fill up one habitually?—I very often put a primary and secondary cause.

Whalan.

9652. (*Chairman.*) With regard to the patient, concerning whom you called in Dr. Mantle to assist in the diagnosis, what would be your opinion supposing he had not suffered from this pernicious anæmia? Would the fact of his having drunk this beer, and the quantity of arsenic that was subsequently found in his body have caused his death apart altogether from the disease?—No. That is really what I wish you to understand, that I do not think if he had taken that amount of arsenic without pernicious anæmia, he would have died. I think he would have got better, as most cases do. Dr. Reynolds reports about 500 cases, and I think he gives 13 deaths. That is not a very high percentage. If we have had three deaths, which I do not admit, our percentage would be abnormally high. Even with the doubtful cases we can only muster 9, and that would be 3 deaths out of 9, which is a very high percentage compared to what Dr. Reynolds has found in Manchester. His cases, I take it, were very acute. The early symptoms were very well marked. People were diagnosed going about the street. There has been nothing of that kind with us. I have dotted a few notes down here, which, perhaps, might give you a better idea of my views on the subject. What has struck me mostly about the cases is, first, the fewness of their number. Our hospital draws from a population of 200,000 people. Taking the well marked cases with the doubtful ones we can only number 9 in the hospital. Secondly, absence of acute poisoning symptoms such as vomiting, diarrhœa, running eyes, rapping step, etc., found in the Manchester cases. Thirdly, the chronic nature of these cases, which suggests to me the long-continued use of little contaminated beer. This will also account for the fewness of the cases. Fourth, the fact that those attacked are people badly fed and clothed, often sleeping out, and also people whose organs have commenced to degenerate from various diseases. Fifth, I have carefully examined heavy beer drinkers, men who told me that they drank from 10 to 30 pints a day, and have found in these people no signs of arsenical poisoning, except in one case, a man who had loss of reflexes. I stripped the men and examined them carefully. I thought it would be rather interesting if I could see heavy beer drinkers and see more pigmentation or some of the early symptoms, which I failed to find. Sixth, most of the beers that have been examined have given traces of arsenic. Therefore, taking a heavy beer drinker, and examining his urine, you will find arsenic, whether the arsenic gives the physiological fact or not. Seventh, one case I am convinced, viz., Shearing, had arsenical poisoning about five years ago, and again two years ago, the last attack being his present one. With regard to Shearing, the patient who is now in hospital, I very carefully went into his case, and I am of opinion now that Shearing years ago had arsenical poisoning. I think he is a very susceptible man. His symptoms, as far as I can gather from him, are identical now to what they were years ago, and they pass off after a certain stay in hospital.

Opinions regarding outbreak.

9653. (*Dr. Whitelegge.*) Will you add the date?—About five years ago was his first attack. Then again two years ago, and lastly the present one. I have no definite day for the first attack. Eighth, I am of opinion that most of the cases have come to the Medical Officer of Health, not because of the notice he sent round to the practitioners, but because most of the medical men in the Halifax district have seen these cases. I myself brought the cases before the Halifax Medical Society on the first Tuesday in February of this year, when I read a paper on arsenical poisoning. The meeting was well attended. One case, Lowrie, no one present would admit was arsenical, except Dr. Neech, the house surgeon, and myself. Then again with regard to the history. I think the history is rather unreliable. I think if you put leading questions to these people sometimes you can get always what you want. With regard to the amount of beer they take, persons very often underestimate. If you ask a man how much beer he drinks he will say very little, and his friends will say an enormous quantity. I think it is very difficult to get the absolute facts of the case.

Mr. W. Thomson.

Mr. William Thomson, called; and Examined.

9654. (*Chairman.*) You have had many years practice as an analytical chemist?—Yes, I have.

9655. Are you at the present moment public analyst for Stockport?—Yes.

9656. You are what is termed a consulting chemist, and work at the Royal Institution Laboratory, Manchester?—Yes.

9657. Will you kindly tell the Commission the extent to which your work has gone as an analyst, that is to say, with regard to any particular industries. Have you examined for the textile trade, or chiefly beer, or what?—My practice is a very miscellaneous one, to a large extent connected with the textile industries, also with mining and chemical products, and so on.

9658. Have you been going through the ordinary work of an analytical chemist for brewers?—Yes, to a very considerable extent.

9659. And therefore your work has really spread over the whole of the area that an analytical chemist might have to work in: it covers the whole of the work of an analytical chemist?—Yes. I have done a great deal of toxicological work also.

9660. With regard to your analyses for brewers, have you done the general work of a brewers' analyst, that is to say, testing as regards the component parts of their brew?—I have from time to time done so, but not as a general rule.

9661. But you are aware that many of the larger brewers do employ an analyst of their own?—Yes. It would be only in exceptional cases in which my services would be wanted.

9662. Did you have much work to do with regard to the unfortunate catastrophe at Manchester?—A great deal.

9663. Since that time you have been employed in analysing beer for arsenic?—Yes, constantly.

9664. In Lancashire?—Yes.

9665. And also as regards Yorkshire and other districts?—Yes.

Recent analyses for arsenic of beer, malt, and brewing ingredients:

9666. Have you had samples sent you from those districts?—Yes.

9667. At the time of the Manchester scare did you examine glucose?—Yes.

9668. Since that time have you been in the habit of analysing glucose?—Yes.

9669. You have sent the Commission some tables, have you not, of the results of some of your recent analyses?—Yes.

NUMBER of SAMPLES of BEER, MALT, &c., Examined for ARSENIC from JULY to DECEMBER 1901, and PARTICULARS of the AMOUNTS of ARSENIC TRIOXIDE Found.

Fractions of a Grain of Arsenic Trioxide per Gallon of Beer. (The larger fraction is inclusive, the lesser one exclusive.)

	1/10 inclusive to 1/20 exclusive.	1/20 to 1/30	1/30 to 1/40	1/40 to 1/50	1/50 to 1/60	1/60 to 1/80	1/80 to 1/100	1/100 to 1/125	1/125 to 1/200	1/200 to 1/300	Free (i.e. less than 1/300).	Total.
BEER:												
Lancashire	–	–	–	–	4	8	6	10	7	1	–	36
Yorkshire	–	2	3	14	48	26	28	19	9	6	–	155
Cheshire	–	–	–	–	2	5	1	–	3	1	–	12
Cumberland	–	–	–	–	–	–	1	–	–	2	–	3
Food and Drugs Act: Samples, Stockport	–	–	1	–	4	1	–	3	1	1	–	11
	–	2	4	14	58	40	36	32	20	11	–	217
	Fractions of a Grain of Arsenic Trioxide per Pound.											
MALT:												
Staffordshire	–	–	–	–	–	–	–	1	1	1	–	3
Yorkshire	2	1	2	–	–	2	3	5	3	4	–	22
Lincolnshire	–	–	–	–	–	–	–	1	2	2	–	5
Cheshire	–	–	–	–	1	1	–	3	–	5	1*	11
Cumberland	–	–	–	1	1	–	–	1	–	1	–	4
Lancashire	–	–	–	–	–	–	–	–	1	–	–	1
Lanarkshire	–	–	–	–	–	–	–	–	–	3	–	3
	2	1	2	1	2	3	3	11	7	16	1	49
GLUCOSE, SUGAR, SYRUP, INVERT SUGAR, CARAMEL:												
Lancashire	–	–	–	–	–	–	–	–	–	1	2	3
Cheshire	–	–	–	–	–	–	–	–	–	2	4	6
	–	–	–	–	–	–	–	–	–	3	6	9
MISCELLANEOUS SUBSTANCES:												
Flaked Rice	–	–	–	–	–	–	–	–	–	–	1	1
Hops	–	–	–	–	–	–	1	–	–	–	–	1
Yeast	–	–	–	–	1	–	1	–	–	–	–	2
Finings	–	–	–	–	–	–	–	–	–	1	–	1
Tartaric Acid	–	–	–	1	1	–	–	–	–	–	1	3
	–	–	–	1	2	–	2	–	–	1	2	8

* This was a highly roasted grain different from ordinary malt.

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9670. A table with some 217 samples taken from Lancashire, Yorkshire, Cheshire, and Cumberland?—Yes.

principally from Yorkshire.

9671. The great majority of these samples appear to have been taken from Yorkshire, 155 out of 217 samples?—Yes. That is in recent times, from July to December of last year.

9672. Have these samples been taken from a very large area, or do they consist mainly of a very large number of samples from one brewer or one maltster?—A considerable number of those are from one brewery in Yorkshire, and they were getting their supplies I understand from different places.

9673. You mean the supply of ingredients?—Malt, hops, and so on.

9674. The ingredients for their brewing came from different places?—Yes.

9675. Can you say from how many brewers or breweries in Yorkshire these 155 samples came?—You may take it there might be two or three in all.

9676. Only two or three?—That is all.

9677. But although they only came from two or three breweries, you wish us to understand that the ingredients cover a large field, because the ingredients came from various sources?—That I presume; I cannot tell you from my knowledge.

9678. This test was applied to the finished article, the beer, in each case?—Yes.

9679. Do you believe in most cases the Yorkshire beer was brewed from Yorkshire malt?—I cannot say.

9680. But it would be most probably the case, would it not, considering there are large maltsters in Yorkshire?—Yes.

9681. You would naturally suppose in most cases this malt was Yorkshire malt?—I suppose it would be prepared in Yorkshire to save carriage. They would sell cheaper in Yorkshire on account of the carriage.

Quantity of arsenic in beers.

9682. I see by your tables that 78 out of these 217 beers show that between 1-60th and 1-20th of a grain of arsenic per gallon has been discovered under your analysis altogether?—Yes. From between 1-50th to 1-80th. One column is 1-50th to 1-60th; the other 1-60th to 1-80th. There are 118 out of 217.

9683. Begin with the 58 and take it backwards?—Yes, 78 out of 217.

All arsenic should ultimately be excluded from beer.

9684. In your experience as an analyst have you formed any judgment as to what would be a quantity dangerous to health to find in beer, or what you would term a negligible quantity?—I do not think it is possible to form, perhaps, any clear notion about that at all, but it seems to me that there is only one method of dealing with it, and that is ultimately to preclude the existence of arsenic in malt.

9685. You think that is the direction in which security should lie?—Yes. That can be done, and will be done if you ask for it.

Samples free from arsenic.

9686. Perhaps you would like to tell the Commission at once what advice you would give to brewers in cases where arsenic has been found in their beer?—All the beers I have examined since 1901 until the present time have contained arsenic, except two. That is by the appliances which I employ for the detection of arsenic, which I have here, and can show you.

9687. Your arrangement for the detection of arsenic?—Yes. The two samples came from Bass. I do not say that all their beers are free from arsenic, but these are the only two samples in eighteen months that I found to be free from arsenic according to my test.

Form of Marsh test employed; destruction of organic matter.

9688. What is this test which you apply?—This test consists in using a much smaller piece of apparatus for generating the hydrogen than usual. The larger the apparatus the less delicate it is. The apparatus I have is shown here. The bulb holds about 50 cc., and it is attached in *this* way to *this* tube containing chloride of calcium, and then to this long tube, in which the arsenic is deposited. (*Apparatus shown.*) The beer or malt is first treated in a flask of about 200 cc. I take 50 cc. of the beer or 5 grammes of a solid, as it is assumed the 50 cc. of the beer would contain about 10 per cent. of solids, which would be about 5 grammes of solids in the beer, as compared with 5 grammes of solids which I should take of malt or other solid substance. This is treated with pure nitric and sulphuric acids until the organic matter has been converted into carbonic acid and water and nothing remains but the mineral constituents. The amount of sulphuric acid left in this flask is just sufficient to go into this apparatus, which is arranged with a thistle tube going, not to the bottom, but simply through the stopper, of the flask. This tube is provided with a glass rod going to the bottom, rounded and ground watertight at the end of the thistle tube. Into this tube is poured the material to be tested. By simply raising the glass rod you can allow the whole or part to run in without the risk of air passing in. By using that apparatus I can detect what is equivalent to 1-1,000th of a grain of arsenic trioxide per lb. of solid material, or about the same amount per gallon. The tubes in which the deposits are made are shown here. They are drawn out in the manner you see, and there is placed in the front of each tube a small roll of dry paper containing acetate of lead. The point near to where the arsenic is to be deposited is heated by a small Bunsen flame, and the arsenic is deposited along the tube. The tubes can be drawn out as nearly as possible to the same diameter, and give therefore a very fair comparison with standard mirrors.

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9689. (*Chairman.*) You are aware, are you not, that there have been great divergencies as regards results in many cases from the same sample of beer or malt?—I am aware of that, and therefore I have made a large number of experiments with a view of getting at a reliable method of working this, so that we can get proper and reliable results. I may pass you these tubes, which will show you the results of different quantities of arsenic which I have added to a sample of wort, which I found to be free from arsenic, and having added these to different portions of this wort I submitted them to the process which I have just described. (*Tubes put in.*) If I might do so, I would put in here a description of this process. (*Diagram shown in Appendix* 18A, *p.* 200 *below.*)

The following is the document referred to:—

Process for estimation of arsenic in beer and stout, malt, caramel, etc.

Beer.—Take of the sample 50 cc., and evaporate on a sandbath or iron plate to a syrup in a 200 cc. Jena glass flask. Add 25 cc. strong nitric acid and 5 cc. strong sulphuric acid, and place on a hot sandbath, having taken away the flame, and allow the first violent action to subside. Then apply a Bunsen flame to the sandbath, and evaporate till the liquid begins to darken, then add strong nitric acid in quantities of 3 cc. at a time (the total quantity of nitric acid required varies from 30 to 50 cc., depending on the quantities of organic matter present), until on further heating it continues colourless and fumes strongly of sulphuric acid, cool, dilute with 10 cc. of water, and boil down to break up the nitro-sulphuric acid formed; by this treatment all traces of nitric acid are removed. When cold, dilute with 10 cc. of water, and deliver into the Marsh-Berzelius apparatus, the capacity of which should not exceed 50 cc., and the gas evolved should be dried over calcium chloride.

Testing re-agents.—A blank on the re-agents and apparatus used should be made by boiling down 100 cc. HNO_3 and 5 cc. H_2SO_4, till all nitric is expelled, diluting and boiling down, again diluting and testing in the Marsh-Berzelius as above described.

Process for malt, sugar, caramel, hops, yeast, etc.—Take 5 grammes malt or other solid organic substance, add 25 cc. HNO_3, and heat till the first violent action is over, then add 5 cc. sulphuric acid, and proceed as for beer (a total of from 50 to 75 cc. of nitric acid will be required).

The Marsh-Berzelius apparatus (50 cc. flask) contains about 20-25 grammes zinc. The $CaCl_2$ in the drying tube should be renewed as soon as the first few pieces become wet.

Action is started by adding 5 cc. of dilute sulphuric acid (10 parts concentrated sulphuric, 20 of water, and 1 part of a 10 per cent. solution of pure copper sulphate) by volume. Allow the evolution of gas to go on (the exit tube for the hydrogen being heated in the usual manner by means of a small Bunsen flame) until the hydrogen nearly ceases to be evolved, then fill up the tube and thistle or funnel of the Marsh-Berzelius apparatus with the solution, previously treated as above, and then raise the stopper rod and allow the whole to run in if only a very minute quantity of arsenic is supposed to be present; or run in an aliquot part if a larger quantity is supposed to exist. In about fifteen minutes the flask is washed with

5 cc. more of the above acid which is added to the hydrogen flask in small quantities at a time to keep up the evolution of gas for a total of from 30 to 35 minutes after the first introduction of the previously treated beer, by which time with this sized apparatus all the arsenic will have passed off.

The hydrogen flame should be about two mm. long, and maintained as constant as possible; too slow a flow almost invariably gives double mirrors, too fast flow gives irregular ones difficult to compare with the standards.

Zinc.—20 grammes of zinc should be tested by the 30 minutes; the action being started with 5cc. of the 30 minutes the action being started with 5 cc. of the above-mentioned acid containing copper sulphate, there should be absolutely no trace of arsenic mirror on the drawn-out portion of the glass tube.

Another experiment should then be made, adding a minute quantity of arsenic, say equal to the 1-500th of a grain per gallon (when working on 50 cc.), equal to 0·029 parts per 1,000,000, or an actual weight of 0·00143 milligramme, and compared with a standard tube to make sure that the zinc contains nothing which will hold back minute quantities of arsenic.

The glass tube for the mirrors should be about 4½ mm. internal diameter and about 6½ mm. external. It should be drawn out in the middle and at the end, the length of the drawn-out portions respectively being 30 mm. and 70 mm., and the portion of tube between the drawn-out portion being 60 mm. The diameter at the beginning of the drawn-out portion for receiving the mirror is about 2 mm. internal diameter.

A piece of fine iron wire gauze 20 mm. wide is wrapped round the tube at the point A, and heated by the Bunsen flame. This is a more satisfactory plan than applying the flame directly to the tube, and conduces to the formation of more even mirrors.

B. is filled with a roll of dry lead acetate filter paper to absorb any traces of sulphuretted hydrogen which may be formed.

Bunsen flame.—This should be about 4 inches long and protected till near the point by a conical iron or copper chimney of about 2½in. high by 2½in. at the lower, and 1½in. diameter at the higher part of the cone.

Heating the tube.—This should be heated from the shoulder or drawn-out portion for about ½ in. at the point (A).

9690. You have also examined during the same period a good many samples of malt for arsenic?—Yes, I have.

9691. In eight out of the forty-nine cases, you discovered between 1-60th and 1-10th of a grain per lb. I think the three highest are taken from Yorkshire malts. Can you tell the Commission what your experience is with regard to the use of fuel in Lancashire or Yorkshire by maltsters?—I think in Lancashire there is now only anthracite employed.

9692. Has this anthracite been employed exclusively since the Manchester catastrophe?—Yes, I believe so.

9693. I do not want to tie you down to every possible case, but as a general result of that catastrophe you believe anthracite is being used by maltsters?—I believe so.

9694. That is what you hear?—That is what I hear, and I understand that the coke market has been seriously affected. The gas coke previously employed for that purpose is no longer used, and it has produced a considerable influence on the market.

9695. You have had a large experience as an analytical chemist in Yorkshire and Lancashire, and you would probably know about the use of this anthracite. When a sample of malt is sent to you it would be sent with the precise information as to what fuel was used?—Yes. I have been told in many cases that coke has been entirely given up, and that only anthracite is used.

9696. When you refer to coke, do you mean gas coke or oven coke?—Gas coke and oven coke, both. Anthracite always contains arsenic, but the coke contains, as a rule, a great deal more.

9697. To avoid possible poisoning in future from arsenic would you recommend great care in the selection of fuel?—I should suggest that the operation be entirely modified so that the fumes from the fuel be not allowed to pass through the malt. This I should think can be done if it is insisted upon; the passing from an old process to a new one is always a difficult step, but if it is done I believe you can do away with any trace of arsenic in beers or in malts being found, even with my apparatus. I have had some malt dried over very hot steam-pipes, and the malt gave absolutely no trace of arsenic by this apparatus.

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9698. Was the malting as thoroughly and as well carried out, as far as you can judge, by that process as by the ordinary one?—The maltster, who made the experiment on a considerable quantity, was not quite sure, but he thought it was not quite as good. But still the same conditions which exist at present can be brought about by the use of other means. For instance, it is possible to heat a number of bricks to redness by ordinary fuel, and then to radiate the heat on to the malt and to allow the hot air to go up to dry without bringing the products of combustion into contact with the malt.

Unequal distribution of arsenic in malt.

9699. Have you often found much difference in two samples from the same bulk of malt?—There is sometimes considerable differences from the same samples. It is obvious that grains of malt lying for the longest time in contact with the floor would contain more arsenic than those at the top of the heap.

9700. The impregnation would not go as far up?—Not so thoroughly. You would get a greater quantity on that which lay longest nearer the floor, and which, therefore, received the gases first. The arsenious oxide I believe condenses on the surface of the grain.

9701. Are you of opinion that by the use of anthracite, or, in fact, any coal or coke carefully picked and selected, security might be obtained?—It depends on what security means. I do not think you will ever get malt without containing appreciable quantities of arsenic by the present methods of drying the malt.

9702. You think that unless some method is adopted of obtaining the heat minus the fumes there will be always some danger of impregnation?—Certainly.

9703. Do not the statistics you have kindly formulated in these columns rather show that, although there is an almost inappreciable quantity of arsenic in very many cases, care has been used in the selection of fuel?—Certainly.

9704. Would not the public be sufficiently safeguarded if you could be assured that in the case of all malting operations the same care was observed as produced these results?—If you will allow me I will show you a card upon which I have fixed the results of tests made during January, February, and March of this year, which show diminishing quantities of arsenic in the malt.

9705. I am anxious you should understand what I mean?—I think I understand.

Question of negligible arsenic in malt.

9706. You give here analyses of 217 cases. Certainly there are some cases which would point to the fact that some carelessness exists as regards the selection of fuel or the use of gas coke, but there is a considerable number of other cases where the quantity of arsenic is inappreciable?—It depends on whether you would say 1-100th of a grain of arsenic per lb. is inappreciable.

9707. What is termed negligible?—Whether it is a negligible quantity. Of course if 2½lbs. went to the gallon of beer, assuming the whole of the arsenic went in, it would be 2½-100th of a grain, which would be about 1-40th. It might be interesting if you would see the results of some tests. These will show you the amount of arsenic from 5 grammes of malt, and the actual amount of arsenic shown in the mirrors, and will give you an idea of the change that has come over the quantities of arsenic found even in recent weeks. (*Tubes put in.*)

9708. In the case of a brewer sending you some beer to analyse, if you found 1-30th or 1-35th of a grain of arsenious oxide in the beer, should you give any advice to the brewer as to what precautions he should take?—No, I should not.

9709. You have not done that?—No.

9710. You merely record the fact?—Yes.

9711. Can you give any information to the Commission with regard to these cases where the larger quantity of arsenic was discovered in the beer: any information as to the particular class of fuel used in those cases?—I am afraid I cannot.

9712. You cannot identify the larger quantity of arsenic in the malt or subsequently in the beer with the use of any particular fuel?—No. But I should assume that in the large quantities, coke must have been used entirely or partially in the drying of the malt.

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9713. Have you examined any beer from the breweries of Halifax?—I think not; not that I know of.

9714. (*Mr. Hammond Smith.*) Did not you get one from Messrs. Webster?—I might have done so.

9715. But I do not think you were told where it came from?—I might have had it.

9716. (*Chairman.*) But you could not call to mind at the moment?—No.

9717. Can you give the Commission any information with regard to the process of brushing malt?—I have no doubt that brushing will improve the quality as regards the quantity of arsenic present.

9718. But you are of opinion that to procure absolute immunity there should be some change in the system of malting?—There must be.

9719. (*Professor Thorpe.*) These samples, of which you give us an account in the digest, came to you professionally?—Yes.

9720. You received them from clients?—That is so.

9721. In the case of the Yorkshire samples, of which you have tested 155 samples, you told us, I think, they came from two brewers?—Two or three. The great bulk from one.

9722. Do you mind telling us in what particular Riding in Yorkshire that was?—Perhaps it would not be wise to mention anything which might identify any special brewer.

9723. The samples of malt you examined from Yorkshire came from the same brewery?—Chiefly.

9724. That is to say, the beer which you examined was prepared from the malt which you examined?—Yes.

Arsenic in his public analysts' samples of beer.

9725. In the case of the food and drugs samples, those you got exclusively from Stockport, of which you are the analyst?—Yes.

9726. What happened in the case of the sample which was reported by you to contain 1-30th to 1-40th of a grain per gallon; was any action taken?—I think not.

9727. Why?—I do not know.

9728. Was any action taken in Stockport at all by the local authority?—I believe not, except warning a great many of them about the quantities of arsenic which were present.

Report to local authority.

9729. In your certificate would you have drawn attention to the fact that in your opinion such amounts as you give here, say from 1-50th to 1-60th, or from 1-30th to 1-40th, were quantities which ought not to be present in beer?—I drew attention to that, but I did not give any advice as to whether it was or was not objectionable.

9730. But you would let the local authority believe that that was an amount which was in your opinion inadmissible?—Yes, that was my own impression about it; and I gave them to understand by drawing their attention to it that that was so, and I believe what they did do was to point these things out to the various brewers, and to warn them, so that the same amount should not be found in future in their beers.

9731. Were these beers that you examined brewed in the neighbourhood of Stockport or in Stockport itself?—In Stockport and the neighbourhood chiefly, but I believe they were also brewed in other places.

Method of testing.

9732. I should like to ask one or two questions about the method of analysis that you have brought before us, because it is obvious you have had a very considerable amount of experience in testing for arsenic by that method. I gather that you prefer a modification of the Marsh method?—Yes.

9733. Why do you prefer that to any other?—Because I have tried all the other methods, and I have been working on it constantly for the last eighteen months by all sorts of devices in all the other methods, modifications in all sorts of ways, and this is the only one that gives tolerably reliable results.

9734. What do you mean by "reliable"?—I mean that if you weigh out a minute quantity of arsenic and give it to me, I believe I can determine within fairly narrow limits what that amount was with almost dead certainty.

Size of flask.

9735. Do you imagine as you work the process that you get away all the arsenic which is introduced?—Yes, within the limits of the flask. I have found that if you take a flask four times that size you would pass a beer as free from arsenic which you would not pass as free if you took the flask that size. It makes a difference even between 50 cc. and 75 cc. capacity. In other words, if you take a 50 cc. flask you will get in half an hour the whole of the mirror; if you take a 75 cc. flask it will take you ten minutes more before you get the whole of the mirror. But if you take it larger than that you may easily miss and pass as free, beer which contains perhaps 1-200th or 1-250th part of a grain of arsenic.

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All arsenic present recovered in mirror.

9736. It is your experience that in from half an hour to 40 minutes, depending on the size of the flask, all the arsenic which has been introduced into the flask may be deposited as a mirror in the tube?—Yes, I think practically all. I have some experiments in which I have dissolved the arsenic from the tube and put it back again, and I have got nearly the same deposit as possible in the one as in the other.

9737. In the same length of time?—Yes. In this apparatus I reduce the whole thing to a very small bulk; in other words, I take in all cases 50 cc. of the beer and evaporate it down in the 200 cc. flask like this to a syrup, then treat that with 25 cc. of nitric acid, and after the first rush of nitrous fumes have gone off I add a little sulphuric acid (5 cc.), and then about 3 cc. at a time until the whole of the organic matter has been destroyed and nothing but the 5 cc. of sulphuric acid, which I had originally, remains, together with the arsenic which is present. It is obvious that on diluting this sulphuric acid, and again evaporating down to get rid of the nitrous fumes, and then diluting that to about 10 cc., and washing it into the apparatus, you get the whole of the arsenic present there without anything to interfere with it. Consequently you get it in a very small volume. I may say that I had, only yesterday, a case in which a most excellent experimenter tested two samples of beer and found 1-33rd grain of arsenic per gallon in each. They were brought to me by another chemist who could not find that quantity, but he found a very small quantity indeed. With this apparatus I found that they contained in one case 1-250th, and in the other case 1-300th of a grain per gallon. He used the Reinsch test, a modification of which he works in an exceedingly expert manner. He is a most able experimenter, but yet we differ in these two methods as between 1-33rd and 1-300th.

Objections to Reinsch test used quantitatively;

9738. I suppose in your experience the Reinsch test is by no means so delicate as the Marsh test?—That is my experience, that it is not satisfactory at all for estimations of arsenic.

9739. What do you mean by not "satisfactory"? Is it not so delicate or is it more difficult to work?—It is not nearly so delicate according to my experience of it. It is not so reliable to compare a delicate white film on the one hand as a black film on the other; the black gives you a much better means of comparison than the white, and you lose arsenic by evaporation in the process, and you do not get the whole of the remainder on the copper.

and to Gutzeit test.

9740. Does that remark also apply to a Gutzeit test where what you have to compare is yellow?—I have made a large number of experiments with the Gutzeit test, and I thought I had obtained a satisfactory result by hanging cotton sewing threads down a long tube and passing the gas up and observing what length of the thread would be coloured yellow by the arsenic in the material which was given off. At first it appeared to give satisfactory results, but afterwards I found it was utterly unreliable. I tried the test with papers, and that, so far as actual figure work is concerned, was utterly unsatisfactory. The test gives an exceedingly pale yellow, which alters very much according to the character of the light by which it is examined. I threw this method over after working with it for a long time. I have tried the tests with nitrate of silver, which gives you a black colour. That I found entirely unsatisfactory, although it is apparently an exceedingly delicate test. After treating the one and the other, and comparing the results, I have been driven to the position that the one which I show here is the only reliable form from which I have been able to get satisfactory results.

Glass used.

9741. In testing by your method, have you found it necessary to be careful of the character of the glass of which your apparatus is made?—Yes; it is better to use Jena glass, but the amount of arsenic dissolved from the glass is very minute indeed. I have some tubes here which would show you the effect of hydrochloric acid standing in contact with the glass. The hydrochloric acid has a great deal more effect upon the glass than sulphuric acid, but it dissolves only an exceedingly

minute quantity, not more than 1-1000th of a grain to the gallon. I prepare hydrochloric acid by a special method which I have devised after a great number of experiments. It consists in diluting fuming hydrochloric acid of about 1·175 sp. gr. with half its bulk of water, down to 1·10 sp. gr., and then treating it with about half gramme of chromic acid to the pint, and distilling. By that means you get over hydrochloric acid contaminated with free chlorine, which, of course, would interfere with the test. It was a difficult matter to get rid of the free chlorine. I made a large number of tests with a view of getting rid of it, such as adding urea and other things to the distillate, but finally I came to this, that on passing air through this distillate containing chlorine I could remove every trace of chlorine in about two hours, and then I got hydrochloric acid which was arsenic free and pure. On leaving that for seventeen days in a bottle I find it had dissolved some arsenic even from the Jena glass, but the amount was exceedingly minute, and would not amount to more than 1-1000th of a grain per gallon. It might be almost left out of account. I think I can show you the tubes here on which that experiment was made. These are the tubes showing the amounts of arsenic.

9742. (*Chairman.*) Those are the tubes you have been referring to?—Yes. You can see that there is a certain amount in the last six tubes. In certain lights you will see that a little has been dissolved after seventeen days, and still more in thirty-five days.

9743. (*Professor Thorpe.*) That was an ordinary white glass bottle of English glass?—No. That was a Jena glass flask in one case, and in the other case it was standing in a green glass bottle. There is certainly a little dissolved, but the amount is exceedingly minute.

9744. Have you used in all these examples the same character of glass throughout?—Yes, the same character of glass throughout.

9745. I notice that in the January samples the glass is highly devitrified, whereas in the February and March samples there is no trace of devitrification?—That may be due to using an open flame or a flame covered with a little wire gauze.

9746. In the latter cases you have wrapped wire gauze round the tube?—Yes, and sometimes we have allowed the naked flame. Recently, we have used the wire gauze because it gives rather better mirrors, but there is not much difference.

9747. I notice you prefer to use oil of vitriol rather than hydrochloric acid?—Yes, because I could not buy hydrochloric acid free from arsenic. I have had all sorts of samples sent from all sorts of places recommended by chemists to be absolutely free from arsenic, and I found they were all contaminated, and therefore I preferred to make the sulphuric acid myself, which was more readily prepared pure and free from arsenic than hydrochloric acid. I could not buy even sulphuric acid which was free from arsenic, and therefore I had to devise a method of preparing an acid which was free from arsenic, and that is done in an exceedingly simple manner by distilling with chromic acid. Adding about one gramme of chromic acid to the pint of sulphuric acid and distilling you get the whole of the arsenic left behind in the retort. One of these two tubes shows the acid containing a large quantity of arsenic, and the other tube shows the result after distilling with chromic acid.

9748. (*Professor Thorpe.*) Is there not a possible objection in the use of sulphuric acid owing to the formation of nascent sulphuretted hydrogen?—You get a trace of sulphuretted hydrogen off almost constantly in all the tests, but by putting a little dry lead acetate paper in the neck of the tube you remove that sufficiently so as not materially to affect the mirrors.

9749. But is there not evidence to show that this nascent sulphuretted hydrogen would cause the retention of arsenic in the flask?—It does not seem to show that. It has been stated that hydrochloric acid gives you better mirrors than sulphuric acid. I have made a number of experiments upon that, and I find no difference if you get pure hydrochloric acid, but the difficulty is to get pure hydrochloric acid. *Mr. W. Thomson.* 17 April 1902.

9750. Of course, I know what is stated; but anyhow you have paid particular attention to the point I have raised?—Yes. I always use pure zinc, which is very difficult to get. I first test zinc samples to see that they are free from arsenic, and afterwards I test them by adding an amount equivalent to the 500th of a grain per gallon of beer, on the basis of using 50 cc. of the sample, to see that I get the proper size of mirror. The electrolytic zinc, for instance, contains a considerable quantity of metallic iron, and the metallic iron holds back the arsenic, and in fact, the iron salts hold back the arsenic when they are in considerable quantities. That is to say a gramme of protosulphate of iron added to the Marsh, for example, will keep back a very considerable mirror of arsenic. I have a series here which I think I can show you which will exemplify the effect of iron in retaining arsenic. (*Mirrors put in.*) Zinc used.

9751. Do you not prefer to use electrolytic zinc?—No, you cannot use it.

9752. On account of the iron which it contains?—Yes.

9753. How do you know that is not electrolytic zinc? I have written to all the dealers in zinc, and have got a large number of samples, tested each in the manner I have suggested, and when I came across a lot which gave the conditions I required, I purchased it all.

9754. How do you know that is not electrolytic zinc?—I do not know where it comes from, but the electrolytic zinc with which I have been supplied was from Brunner, Mond and Company. It might have been electrolytic zinc from which I obtained the required supply, I do not know. It is possible by distilling electrolytic zinc you may get it free from iron and arsenic. At all events, I have had very great difficulty in getting zinc free from arsenic. I have had a large number of samples submitted to me as free from arsenic, and I have tested them and found them to contain arsenic. So that when I find, say, 20 lbs. of a certain kind of zinc which is free from arsenic, and gives the proper size of mirror when working with 50 cc. of a solution containing the 500th of a grain per gallon, I purchase it all—14lbs., 20lbs., or whatever it is I can get.

9755. (*Dr. Whitelegge.*) With what object do you destroy the organic matter in your test?—Simply to get the conditions the same in each case. Object of destroying organic matter.

9756. Have you made any comparison to show whether the amount of arsenic recovered is increased if the organic matter be destroyed?—The mirrors are not so satisfactory when the organic matter is not destroyed. You do not get the same clearness of mirror when the organic matter is present; beers frequently contain sulphites which interfere with the test, but which are removed by my process, and in many cases the mirrors are not obtained at all when the test is made directly on the beer. Those are my reasons for not having the organic matter present at all.

9757. It is not from any idea that the organic matter will keep back the arsenic?—No, it does not always keep it back completely.

9758. The printed tables relate to samples examined by you in the second part of 1901?—Yes. I have a further table showing the results up to April, 1902, which, if you wish it, I might put in. The following is the table:— Improvement in beer and malt in 1902.

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NUMBER of SAMPLES of BEER, MALT, &c. Examined for ARSENIC from 1st JANUARY to 8th APRIL 1902, and PARTICULARS of the AMOUNTS of ARSENIC TRIOXIDE Found.

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Fractions of a Grain of Arsenic Trioxide per Gallon of Beer. (The larger fraction is inclusive, and the lesser exclusive).

	1/10 inclusive to 1/20 exclusive.	1/20 to 1/30	1/30 to 1/40	1/40 to 1/50	1/50 to 1/60	1/60 to 1/70	1/70 to 1/100	1/100 to 1/125	1/125 to 1/200	1/200 to 1/300	Free (i.e. less than 1/300th)	Total.
BEER AND STOUT:												
Lancashire	–	–	–	–	–	–	–	–	–	1	–	1
Yorkshire	–	–	–	4	9	9	–	5	13	12	–	52
Staffordshire	–	–	–	–	–	–	–	–	1	5	–	6
Food and Drugs Act:												
Samples, Stockport	–	–	–	–	–	1	–	–	–	–	–	1
	–	–	–	4	9	10	–	5	14	18	–	60

Fractions of a Grain of Arsenic Trioxide per Pound.

MALT:												
Staffordshire	–	–	–	–	–	–	–	–	–	1	–	1
Yorkshire	–	–	–	–	2	–	1	1	2	9	–	15
Lincolnshire	–	–	–	–	–	–	–		1	10	2	13
Lancashire	–	–	–	–	–	1	–	–	–	1	–	2
	–	–	–	–	2	1	1	1	3	21	2	31
MISCELLANEOUS SUBSTANCES:												
Tartaric Acid	–	–	–	–	–	–	–	–	–	4	–	4
Cream of Tartar	–	–	–	–	–	–	–	–	–	3	1	4
Sweetmeats	–	–	–	–	–	–	–	–	–	–	1	1
	–	–	–	–	–	–	–	–	–	7	2	9

9759. In the second part of 1901 there were still samples of malt containing very considerable proportions of arsenic?—Yes.

9760. And two containing upwards of 1-20th; one containing upwards of 1-30th; and two containing upwards of 1-40th of a grain per lb.?—That is so.

9761. Can you say when those malts were made?—I cannot.

9762. You have compared those figures with the results you have obtained since that time?—The amounts have been gradually going down. I believe at one time there were train loads of malt, about the beginning of last year, which could not be used, sent into the Manchester district. What became of these train loads of malt I do not know; but they had to supply a better class of malt to the Lancashire brewers than to any of the other districts of England, I understand.

9763. The latter table shows that out of 31 samples examined this year none contained more than 1-50th?—That would be right.

9764. Whereas out of 49 examined in the second half of 1901, six contained a larger amount than that?—Yes, that would be so.

Personal view that over 1-100 grain per gallon is adulteration.

9765. In the return you were good enough to send to the Commission you say that as the result of analyses under the Sale of Food and Drugs Act you give a formal certificate in all cases, but up to the present time you have only regarded as adulterated those samples of beer containing more than 1-100th of a grain?—That is my personal view of the matter. Of course, it would not be anything more than a personal view.

9766. But that represents your practice at that time?—Yes.

9767. And your present practice?—Yes. I should prefer that there should be none present, but as all beer contains arsenic you must fix some limit for the present at all events.

9768. And in the case of beer containing more than 1-100th of a grain per gallon you would give a certificate in an official form which would enable the local authority to take proceedings?—Yes, I draw attention to it, and let the medical officer take proceedings if he thinks it advisable.

9769. A formal certificate complying in all respects with that which would be required if proceedings were to be taken?—Yes.

Official test needed.

9770. You say also you are not in favour of a standard test for arsenic; do you still hold that opinion?—I think at the time I expressed that opinion there was nothing very clear or definite to go by. I do not know that it will be advisable to fix any standard test now, but I think it is desirable to have an official test, if possible, because there are so many tests and so many methods of doing those things, that it would be desirable to have an official test.

9771. You told us that, in your opinion, it would not be possible to exclude arsenic altogether unless the malting were so conducted that the fumes could not gain direct access?—Yes, I am satisfied on that point.

9772. Are you able to point to any place where that is done on a commercial scale?—So as to prevent the fumes?

9773. Yes?—No. But I know of one place where an appliance is being arranged for that purpose.

9774. Is that the case of which you gave us particulars?—One where bricks are heated to redness, and the radiated air from the bricks allowed to go into the malt.

9775. That plan is, I understand, being tried experimentally by a maltster in this country?—Yes.

9776. With a view to adopting it on a large scale if it proves successful?—That is so.

9777. Is that the same case as that which you have already mentioned in which a brewer was making experiments?—The brewer does also his own malting to some extent, and it is the brewer who is making that experiment.

9778. I only want to be clear that it is the same case?—That is so.

9779. Does it fall to your lot to advise the brewer who is a maltster, or maltsters, as to the conduct of the process?—No, not at all.

9780. Can you give us any idea of the amount of dust that is removed from the malt by brushing?—I cannot tell you that. It cannot be a very large amount, I should say.

9781. You mentioned that in one case you found 1-30th of a grain of arsenic in a sample of beer?—Yes.

9782. And that in your case you did not make any representation to the brewer?—I did not make any representations to the brewer.

9783. That I follow; so that you can tell us nothing of what happens in the case of those contaminated beers?—I do not know what happens. I cannot tell you whether they are sent out or what they do with them.

9784. You have examined, no doubt, not only these substances which are included in the list, but also samples of fuel?—Yes.

9785. Can you say how much arsenic is found commonly in anthracite?—I have given it in some of my papers, but I cannot remember exactly the amount. It comes to something like 1-100th or 1-50th of a grain per lb. It is a very small amount.

9786. Even less than that?—Probably less than that.

(The figures are:—Coke from ½rd to 1-100th, anthracite from 1-100th to 1-500th.)

9787. Have you arrived at any conclusion as to what the proper method of sampling fuel would be—anthracite in particular?—The only method of sampling would be to take a considerable quantity, break it into small pieces, and mix it together thoroughly, and pick a lot of that, break it into smaller pieces, gradually breaking down until you get nearly to a powder. Then take a sample of that for the analysis.

9788. But all this after first removing any obvious lumps of pyrites?—If it is the custom to remove pyrites they should do that first. But if it is not the custom to remove the pyrites then the pyrites should be mixed together with it in proportion as nearly as possible.

9789. But you would regard it as necessary to remove pyrites as far as possible?—I should say so, certainly. If you had pieces of pyrites you would not burn them.

9790. In your return you mentioned finding arsenic in a sample of chicory?—Yes.

9791. Have you formed an opinion as to the source of the arsenic?—Not at all. I only assume that the chicory must have been roasted over the fumes of the fuel.

9792. Do you give us the amount of arsenic found in that case?—I think I have done so. I have not got it at hand.*

9793. Dr. Buchanan tells me it is not given in the return?—I know that it was determined.

9794. You also found arsenic in liquorice sweets, did not you?—Yes.

9795. There also we have not the amount. Would it be possible for you to supply it to us?—I think I have the amount. I can let you have it.

9796. (*Chairman.*) You might forward it to us?—I will do so.*

* The following are the amounts of arsenic I have found in these articles:—

	Approximate amount of arsenic expressed as arsenic trioxide.
Liquorice jujubes	1-35th of a grain per lb.
Stick Spanish juice	1-70th " "
Chicory	1-150th " "

9797. (*Dr. Whitelegge.*) Can you tell us anything of arsenic in connection with textile goods?—Yes. I have had a large experience in that. There is a considerable quantity of textile fabrics containing arsenic in minute quantities. That is regarded most seriously by the Norwegian and Swedish Government, where they take notice of very minute quantities. *Mr. W. Thomson.* 17 April 1902. in textile goods.

9798. Is this entirely in the colour?—Chiefly in the colour.

9799. And the regulations of Norway and Sweden prohibit the import?—Yes. They used to prohibit the import of any cloth containing even the most minute trace of arsenic; now they allow a little, but it is very small indeed. regulations in Norway and Sweden against arsenic.

9800. Does any similar rule prevail in other countries?—I think so to some extent, but they are not so strict as they are in Norway and Sweden.

9801. (*Chairman.*) You have had very many years' experience as an analytical chemist?—Yes, about 30 years.

9802. And, of course, since this Manchester catastrophe you have given additional time and labour evidently to this process of analysis?—I have.

9803. I suppose you admit, do you not, that your evidence here to-day goes to prove conclusively that extreme care is necessary as regards analysis for the detection of arsenic?—If the process is carried out in a certain way only the ordinary care is required.

9804. But you quoted before us a case which happened within the last few days where there was a difference between 1-33rd and 1-300th from the same sample?—Yes.

9805. If you were to change places with myself, and were pursuing an investigation of this kind, you would find that rather a disturbing element where you are investigating a matter of very serious moment to the public health?—Yes.

9806. If you had to come to a conclusion and write a report, you would find it a very disturbing element?—Certainly. But the Reinsch's test is one which depends upon the personal equation to a very large extent. In the test I use it does not depend on the personal equation. Anyone can get results from this method I have pointed out to you, but they cannot get the same result by other methods. I am satisfied that the Reinsch's test is not satisfactory for determining minute quantities of arsenic. Objections to quantitative Reinsch method.

9807. You condemn that as a test?—Yes, as a quantitative test.

9808. But you are of opinion that uniformity of treatment and method in the case of analysis are necessary?—I think so now.

9809. From recent experience and from cases you quoted to-day you have rather modified your judgment as to necessity for uniformity of treatment?—It seemed to me there were so many methods of treating the matter at one time that it was not advisable to arrive at a decision as to the process until it had been investigated thoroughly. From my own investigations I think there should be now a definite process adopted. Nature of official test recommended.

9810. Is the test which you have been detailing to us to-day so thorough a test that it is of universal application?—Yes, almost, but there are certain modifications which I have suggested to you. One of them, notably the size of the flask and the others the methods of purifying the re-agents. There has been suggested a method of purifying hydrochloric acid by adding bromine to it. I have been unable to get hydrochloric acid free from arsenic by that method, but I have got hydrochloric acid absolutely free from arsenic by the method I have described, by means of chromic acid. These are the conditions which must be first attended to. The question of the purity and suitability of the zinc, and of the purity of the sulphuric or hydrochloric acids, is most important. Nitric acid is almost certain to be free from arsenic, but it should always be previously tested.

9811. As it stands to-day, in the light of your experience, is this test which you now apply in general use amongst analytical chemists?—Yes, some modifications of it. They usually employ larger flasks than I do, and they will not get such delicate or accurate results.

9812. (*Sir William Church.*) You said that you would approve of an official test, but not a standard test?—I think that if there is an official test you might use any test you like, but you must make one official test, and show what the result is by that one test. You then concentrate attention upon that official test and cut it to pieces if possible. If you can get a better official test

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you may adopt it. But I think the Marsh-Berzelius test, under stipulated conditions, might be used as the official test; and if you can by any other means get a better test than that, it would be permissible to make use of that other test, providing you can show it is better than the official test.

9813. You mean by "official test" what I should have meant by the standard test; that is, you think it would be possible to have an official test that everything should have to pass?—Yes, I think so.

9814. It is a difference in terms?—Yes. A standard test may be taken as the test, from which there would be no moving; that must be the test which would absolutely fix it. My notion is, that if you can find arsenic in malt, beer, or other food by any means whatever, we should, if possible, try to get rid of it, and that its presence should condemn the material. But if you have a standard test you may find there is some method which is better than that standard test, or simpler, which might ultimately be adopted, and I think therefore the test should be regarded simply as an official test, and not as a final one. But if you have one test put forward it allows criticism in that test to be made by a large number of chemists so as to get a better test if possible. In this test I estimate so many grains per gallon, or so many parts of a grain per gallon, based on the assumption that you take 50 cc. for a test, and you get a certain figure from the arsenic mirror produced of so much per gallon based upon the 50 cc. being taken, which is equivalent to a sherry glass full.

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9815. I think I understand that an official test would be the test in which the quantities of the materials to be analysed and the various steps in the analysis could be laid down, and you objected to the term "standard test" because you thought you could not go beyond it?—That is so.

Mr. THOMAS FAIRLEY, called; and Examined.

Mr. T. Fairley.

9816. (*Chairman.*) You have been for many years an analytical chemist?—About 30 years.

9817. How long have you been public analyst of Leeds?—From 1873.

9818. Have your analyses been with reference to many articles of food materials and manufactured materials?—A great many different kinds of things, food and waters, coal-gas, and coals, and articles referring to the local manufactures of the West Riding of Yorkshire.

9819. With regard to analysing samples of beer, I suppose you have had long practice of that?—As regards arsenic in beer only since the scare began in Manchester. The question was not raised before that time. I had no idea that arsenic might be present.

Limits of Expert Committee's test.

9820. Have you acted as a special analyser of beer for any firm?—From the beginning of 1901, two of the large breweries in the Leeds district employed me to test, either by myself or through my assistants, all the brews for a time. That was done by means of the test recommended by the Brewers' Association at Manchester, which, of course, is not a delicate test, as Mr. Thomson has said. According to my experience, as a rule it has detected 1-20th of a grain per gallon, and with special care 1-50th of a grain per gallon.

Mr. T. Fairley.

9821. For detection?—Yes. Beyond that without concentration I think it fails.

9822. You mean that in a case where there was 1-150th of a grain only present that the process you used would fail to detect anything?—The process I used up to about February, 1901, for passing these beers for these breweries would not detect at the outside more than 1-40th of a grain or 1-50th of a grain.

9823. That is to say, the presence of arsenic less than that would go undetected?—Yes, undetected without concentration, which was not done.

9824. I suppose since the Manchester scare you have had plenty to do with regard to analysing samples of beer?—I have summed up the number of beers that I have done during the time, and they are close on 300, really 298. I have brought with me a table showing the results which I obtained. (The following was handed in):—

ARSENIC IN MALTS.—TESTED DURING 1901–2.

Malts free from arsenic	43
Malts containing arsenic	10
Total	53

The 10 arsenical malts contained the following amounts in grains per pound.

	Arsenic trioxide.	
One sample	0·052 or about	1–20th.
One sample	0·035 „	1–30th.
One sample	0·020 „	1–50th.
Two samples	0·016 „	1–60th.
One sample	0·010 „	1–100th.
One sample	0·008 „	1–120th.
Two samples	0·004 „	1–240th.
One sample	trace	

ARSENIC IN COKES, &c.—TESTED DURING 1901–2.

Cokes free from arsenic	2
Coke containing 0·17 grain of arsenic trioxide per pound	1
Coke containing 0·013 grain of arsenic trioxide per pound	1
	4

The cokes containing arsenic were gas cokes from coals obtained locally. The cokes free from arsenic were from coke manufacturers from washed or picked coal.

ARSENIC IN TILES AND DUSTS FROM MALT KILNS.

See paper "The Analyst" July 1901, page 177.

ARSENIC IN DUSTS ELSEWHERE.

Dust from shelves, Fairley's laboratory, 0·7 grain per pound.
Dust from shelves, Mackey's laboratory, 0·77 grain per pound.
Dust from shelves, Metallurgical laboratory, Leeds Institute, 1·4 grain per pound.
Dust from bookcase over books, Fairley's office, 0·4 grain per pound.
Dust from shop, Commercial Street, Leeds, 0·3 grain per pound.

Mr. Fairley. — April 1902.

Mr. T. Fairley. — 17 April 1902.

ARSENIC IN MATERIALS USED IN TESTING.

No "pure" acids, hydrochloric or sulphuric, have been obtained free from arsenic by the Marsh-Berzelius test. At least 60 samples of zinc sold as "pure" have been tested for arsenic; of these only about five or six have been found pure so as to stand 30 minutes' Marsh test. Some "pure" zinc has the property of keeping back arsenic, as proved when a known amount was put into the apparatus. This was shown more especially when sulphuric acid was used. It is important that the cause of this interference should be ascertained.

ARSENIC IN GLASS.

Two samples after standing twenty-four hours in hydrochloric acid of 20 per cent. contained arsenic in solution:—

One corresponding to 0·003 grains of arsenic trioxide per pound.
One, trace.

Two samples of beer bottle glass fused with sodium carbonate gave:—

Light colour - - - - - - - - - - 0·03 grain of arsenic trioxide per pound.
Dark colour - - - - - - - - - - 0·50 " " "

One Winchester Quart, such as is used for storing acids, contained:—

1·00 grain of arsenic trioxide per pound.

One sample of Jena glass used for chemical apparatus contained:—

2·1 grains of arsenic trioxide per pound.

ARSENIC IN BEERS—TESTED DURING 1901-2.

Beers free from arsenic - - - - - - - - - - - - - - - - - -	280
Beers containing arsenic - - - - - - - - - - - - - - - - - -	18
Total - - - -	298

The 18 arsenical beers contained the following amounts in grains per gallon of beer:—

	Arsenic trioxide	
One sample - - - - - - - - - - - - - - - -	0·16 or about	1-6th.
One sample - - - - - - - - - - - - - - - -	0·03 "	1-30th.
Three samples - - - - - - - - - - - - - - - -	0·025 "	1-40th.
Two samples - - - - - - - - - - - - - - - -	0·02 "	1-50th.
One sample - - - - - - - - - - - - - - - -	0·016 "	1-60th.
One sample - - - - - - - - - - - - - - - -	0·015 "	1-65th.
Two samples - - - - - - - - - - - - - - - -	0·013 "	1-70th.
Two samples - - - - - - - - - - - - - - - -	0·01 "	1-100th
Three samples - - - - - - - - - - - - - - - -	0·007 "	1-150th.
One sample - - - - - - - - - - - - - - - -	0·005 "	1-200th.
One sample - - - - - - - - - - - - - - - -	trace.	

Locality.	Samples Tested.	Arsenic Trioxide (in grains per pound).
Escrick, Yorks -	Superphosphate - - - - - - -	11·06.
	Soil - - - - - - - - -	0·017 (Total).
	Soil (extracted with 1 per cent. solution of Citric Acid) - - - - - - -	0·003.
	Oat stubble grown on above soil - -	Trace (probably from a little earth.)
	Oats (ears only) - - - - - - -	None.
Rotherham - -	Soil (turnip field) - - - - - -	0·003 (Total).
	Turnips from above - - - - -	None.
	Soil (barley field) - - - - - -	0·14 (Total).
	Soil (extracted with 1 per cent. solution of Citric Acid) - - - - - - -	0·002.
	Barley (ears only) - - - - - -	None.
Overton near York - -	Soil - - - - - - - - -	0·035 (Total).
	Superphosphate - - - - - - -	11·06.
	Barley (roots) - - - - - - -	None.
	Barley (straw and ears) - - - - - -	None.
Malton - -	Barley (grain) - - - - - - -	None
Boroughbridge - -	Wheat (grain) - - - - - - -	None.

9825. Are these analyses which have taken place since the Manchester scare?—They have all taken place since December, 1900.

9826. That was after the scare?—Immediately after the scare.

9827. Are you aware that extra precautions immediately after the scare were taken by brewers and maltsters?—Certainly; many of them did at all events to my knowledge.

9828. You give here 298 samples?—Yes.

9829. And out of these you say that 280 were free from arsenic?—Yes, by the test I employed. When we found arsenic by the Reinsch test we did not attempt to use the Reinsch test as a quantitative test, but we estimated the arsenic by the Marsh test. The Reinsch test is, strictly speaking, only a qualitative test, a good confirmatory test.

9830. You mention in your report arsenic tri-oxide; is that the proper term?—That is the chemical name.

9831. I ask you the question because when this evidence appears it might appear it was something fresh you discovered to people not technically acquainted with chemistry?—It is the chemical name.

9832. In one sample you say 1-6th of a grain of arsenic tri-oxide was found in a gallon of beer?—Yes; that was a sample from the North Riding. I am also public analyst for the North Riding of Yorkshire. The Medical Officer took samples, and this was one of them.

9833. Can you say what led the Medical Officer to take samples? Was it his usual habit to do so?—No. These were the first he sent me.

9834. Was it the first occasion on which he had sent you samples of beer?—Yes.

9835. Do you know why he did so?—Only from what he would read in the newspapers. I do not know that he observed any illness.

9836. With regard to this sample of beer, I do not ask you to detail to the Commission what brewery precisely it emanated from, but could you follow it sufficiently to be able to tell the Commission whether the malt used in the brewing of it was made with the use of gas-coke or anthracite coal?—I can only tell you from what I was told outside. I was told that Bostock's sugar had been used in making this particular beer, but I do not know that for certain.

9837. But you have heard that?—Yes.

9838. Did you hear it given as a reason for finding this large quantity of arsenic?—No.

9839. But you heard it stated in the case of this sample that Bostock's sugar had been used?—Yes.

9840. Could you give us the date?—December, 1900. I can give you the exact date.

9841. (*Sir William Church.*) That was just after it had been discovered?—Yes.

9842. (*Chairman.*) With regard to the two following examples, in each case 1-30th and 1-40th, did you identify that at all with Bostock's sugar?—No, I am not certain about that at this moment. It might have been.

9843. But you could not identify them?—No.

9844. Have you been testing samples of beer up to quite lately?—Yes. I am constantly testing them. In all the samples we have tested this year, and for part of last year, we have abandoned the Reinsch test and are using the Marsh apparatus. The apparatus I use is four to six times the size of Mr. Thomson's, but I agree with him the small apparatus with a small quantity of zinc and a small quantity of acid would be a better arrangement than mine.

9845. You think it would tend to give a more accurate result?—I think the smaller the quantity of chemicals you use for testing for a given substance, speaking generally, the more accurate your results would be, considering the extreme difficulty of getting substances chemically pure.

Quantity of arsenic in recent beers.

9846. Could you tell the Commission whether during the last few months you have tested any samples of beer which have produced a considerable quantity of arsenic per gallon, say anything like 1-40th or 1-50th?—During the last few months I think I have had one or two containing 1-70th. That was sent to me by a brewing firm for which I act as analyst. That was evidently unsafe for them to send out.

9847. You think 1-70th would be unsafe?—For a brewer to send out, yes.

9848. But you have not found many such samples?—Very few.

9849. And you think, on the whole, that the fact that greater care is now taken on the part of the brewers and maltsters in testing all the ingredients has produced good result?—Yes, so far.

9850. Does your experience in testing samples, which you are doing every day, go to confirm the improvement in this respect?—I am not prepared to say that about malts.

9851. You produce 296 samples of beer out of which 280 you mention to be free from arsenic?—A large number of these would have been tested by the Reinsch test only.

9852. You say if a more severe or searching test were applied, arsenic in very small quantities might have been discovered?—Yes. When it is worked out I think that the Reinsch test would not have enabled me to report that. The Marsh test as employed by me, with a four to six ounce flask, would not enable me to go to anything like the thousandth of a grain. About 1-250th would be about my quantity. I have not reported in this statement anything below that amount.

and in recent malts.

9853. Have you examined many malt samples during the last twelve months?—53 have been done during 1901-1902, and about half of them has been done during the last year.

9854. Will you tell the Commission generally with what results?—About 25 per cent. of these were found to be arsenical by the test which I use; 10 out of 53, or more like 20 per cent.

9855. What about the average of arsenic tri-oxide found; could you give us the maximum and the minimum?—The maximum is ·052, or 1-20th of a grain; the minimum was one marked "a trace," which I did not attempt to define; the minimum that I have estimated here is the ·004, or 1-250th of a grain. I have not put down decimals beyond the third place, so that the numbers do not exactly correspond.

9856. Were there many samples in which the maximum amount occurred that you mention there?—I think one.

9857. Then I suppose you are prepared to state that the result of your examination of these malt samples, taken as a whole, was satisfactory?—Taking the 53, it was satisfactory as regards the 43 that I passed; but I think it shows the need for further care on the part of the 10.

Analyst not always informed of fuel used.

9858. Could you give us any information with regard to where the higher results were obtained, as to what fuel was used in such instances?—I do not know for certain, but I believe gas-coke was used. I am not always informed by the maltsters or brewers who send me these malts.

Arsenic in tiles of kilns.

9859. I suppose now they are quite awake to the fact that there is danger where there is carelessness as regards fuel?—That is so. I attempted to draw their attention to the point that it was not sufficient to change from gas coke to a pure coke or anthracite, but that they must clean out their kilns very carefully. I made an investigation myself, examining the tiles of the malt floors, and the dust on the underside of these tiles, and the dust on the side walls above the malt floors. The walls were sometimes brick walls of a rough surface, and the dust was accumulating there. I found very considerable quantities of arsenic in that dust, not only from an old-fashioned kiln where the fireplaces were put in the very thick walls round the lower chamber below the upper chamber, which was the malting process place proper, but also in the most recent kiln, the modern form of kiln. I found in the dust from the lower side of these floors as much as one per cent. of arsenic in this dust, an astounding and extraordinary amount, which I could not believe at first. But we repeated the test a good many times. I have the dust; if anyone would like to prove it I should be willing to supply it to them.

in kiln dust up to 1 per cent.:

9860. You have still a sample of this dust?—Yes. I also found in some of these tiles, some of the older tiles, what are called Stowmarket tiles, containing not ordinary fire clay, but clay containing a good deal of lime; the tiles are somewhat porous. They could not be fired in the ordinary way of tiles, as they would have run. I found in the substance of these tiles, in the material itself, very considerable quantities of arsenic. When I found this out I recommended to the breweries that employ me to by all means clear out the kilns thoroughly, do away with all the old tiles, and have the roughly sound glazed tiles put in their place, otherwise they might change their fuel without changing the results, and still get arsenic in their malt. I made a calculation. Taking the average of the arsenic that I found in the ten arsenical malts, how much of this bad dust would be necessary in the quantity that chemists usually operate upon, ten grammes, about one-third ounce, to give the average arsenic which I have found, something like ·015, and of the very worst dust 1-40th of a grain of that dust adhering to the malt would be sufficient to explain these results. There was the dust on the side walls, of which a larger quantity would be necessary, I think about one grain. In order to try, if possible, to throw some light on the extraordinary differences which different analysts have got when testing malts, I began testing, as I found that some of the London chemists said that the dust in their laboratories, if it got into their apparatus, would be liable to affect the results. I tested the dust on shelves in my own laboratory, and in another chemist's laboratory in Leeds, and in a metallurgical laboratory in Leeds, and I found in my own ·7 grain per lb. of arsenic, and in my colleague's ·77, and in the metallurgical laboratory 1·4 grain of arsenic per lb. of the ordinary dust. I also brushed down the dust from the tops of some of my books in the office, apart from the laboratory, and I found in that ·4. Also in the shop in a main street in Leeds I spoke to a friend who got the dust from some of his shelves, and I found in that ·3. So that where there is a large amount of black smoke, sooty smoke, prevailing, as we have in many of our manufacturing towns, and especially where fireplaces do not draw very well, and you have smoke coming into the rooms, you will find arsenic in the dust. That shows the extreme precautions necessary.

in dust of towns.

9861. You think that the necessity for cleanliness and great care as regards preventing any deposit of malt dust anywhere in a malting establishment is most essential?—Yes, and the very careful cleaning of the malt by brushing.

9862. I suppose you are equally alive to the fact that a large amount of evidence has been given in regard to gas coke; that where gas coke has been extensively used arsenic has been found in the malt. Can you give the Commission any suggestion or recommendation with regard to the use of fuel or what fuel should be used?—I think that with carefully prepared coke, prepared from coal that has been picked or washed, as some of it is, washed so as to get rid of the dirt and most of the pyrites, you might get a coke which does not show arsenic up to a certain limit of test. But with gas coke I have found ·17 grain of arsenic per lb. of coke, and I analysed two samples of coke, and found in another one a smaller quantity, about 1-10th of that. I analysed two cokes sent by coke manufacturers which were prepared mainly for use in the ironworks, and are also sold to the maltsters, but I was not able at that time, early last year, to find arsenic in these cokes.

9863. Can you tell the Commission your experience with regard to the brushing of malt?—The malts which I have passed as free from arsenic were all of them carefully brushed.

9864. Do you think that is a necessity?—Certainly.

9865. Have you ever found any discrepancy in the finished material, the beer, and in the amount of arsenic found in the malt used. Have you found a difficulty in tracing the precise amount?—I have not been able to follow that.

9866. Discovering arsenic in a malt and following it on into the beer?—No.

9867. Have you found a case, for instance, where a malt has been found nearly wholly free from arsenic, and an appreciable amount has been found afterwards in the finished article?—Not that I can speak with any degree of definiteness. I do not know as a rule when I test samples of beer what malts were used for that. I do not test the malts at the same time so as to connect the one with the other.

9868. You have not been able to follow the process through?—I think it is very desirable it should be followed through by somebody, but I have not done it—beginning with the coke and going on right through.

9869. When you are engaged in testing samples for brewers for their protection and the protection of the public generally, do you use precisely the same test that you use in your capacity as public analyst?—Certainly; whenever we find arsenic the tests are repeated at least three times. If the amount is at all great, then we get the Reinsch test, and get the arsenic crystals as confirmatory evidence. I had a maltster complaining to me the other day that I had reported more arsenic than somebody else reported. I said, "I can show it to you; here it is." I showed him the crystals in the tube.

9870. Was that the third and last test?—No. I was speaking of three times by the Marsh test. I was not meaning that as a quantitative test at all.

9871. Did you convince him?—I think so. He might think it was in my materials.

9872. Is it true that, according to the analyses given to the Commission of the Yorkshire Brewery Company, you have tested their beer up to February last by the Manchester expert's test?—I had a large number of samples from them, but I do not know where these beers were sent or anything about them. I tested them either in my office or at their works.

9873. That is all you know?—That is all I know.

9874. By that test would any arsenic be liable to escape recognition?—At what date is the test you refer to?

9875. February this year?—We should use the Marsh test.

9876. Have you anything to say with regard to plants taking up arsenic from arsenical soils or otherwise?—I began investigations last year, and wrote to a large number of farmers and agricultural clubs which I happened to know in the county of Yorkshire. In some cases I got responses, and the results are tabulated in one of these sheets. I was easily able to detect and estimate the arsenic in the manures and in the soil, but so far not in the plants, unless in the roots of the plants, where there was a doubt whether the traces of the arsenic I found might not be due to the soil adhering. I am perfectly aware that my experiments were different from what a chemist at Newcastle has discovered, but his experiments were made on plants cultivated in pots, and I think his arsenic was dissolved in the alkaline solution. My opinion, from the results I have got, is that the basic constituents, such as oxide of iron, appear to neutralise the arsenic that might be present, so that it never enters into the circulation of the plants. We do know from the experiments made in Germany that a very minute quantity of arsenic kept in solution by excess of alkali applied to plants in pots kills them, just as it kills other living beings. It interferes with the physiological processes. (*See note at end of evidence.*)

No arsenic detected in plants grown on arsenicated soil.

9877. So far as you have gone then, the results are satisfactory?—They are negative in the sense that I have not proved the presence of arsenic. It would have been better if I had made a full analysis of the soils.

9878. So far as your researches have gone as regards the process, the effect on a growing plant, the evidence is satisfactory?—The evidence is that it has no influence.

9879. (*Professor Thorpe.*) What led you to employ the Manchester test in the first instance?—It is a convenient test, and I thought at the time it would be sufficiently accurate for this purpose. I admit I was mistaken. I did not know what I know now, that it might pass amounts which might be dangerous.

Present objections to Expert Committee's test

9880. Then you certainly would not recommend that the Manchester test, as we may call it, should be used as an official test?—I should recommend, if used at all, it should be only used as a confirmatory test.

9881. You heard Mr. Thomson's evidence, I think?—Yes.

9882. Do you agree with him that in the present state of matters it would be desirable that somebody should prescribe an official test?—I agree with him in a great measure; but at the same time I do think the whole subject requires further investigation. For instance, this question of zinc sold as pure, sometimes it keeps back arsenic when we put it in. The cause of that is not understood. You have only to consider this impurity (or extreme purity which ever it may be) balancing a minute amount of arsenic in the zinc, in order to get a condition of things which would be very misleading, and which may possibly explain some of the differences in results by different tests.

Zinc keeping back arsenic in Marsh test.

9883. When you say that zinc keeps back arsenic, what idea have you of the way in which that is done?—I think it may be probably due to some metallic oxide or sulphide present in the zinc depending on the process employed in the purification of zinc. That is only an idea in my own mind, which wants testing by actual trial.

9884. Are you quite sure of the fact that you can get the sample of zinc that has this property of keeping back arsenic?—I am not only sure of it, but I have met other chemists who are sure about it.

9885. Is it the zinc or possibly the acid which is the means of keeping back the arsenic?—It is more readily shown when sulphuric acid is used that is all I can say; but it is the zinc. One sample of zinc does this, and another sample of zinc does not.

9886. It may be the fact that it is more readily shown in the case of sulphuric acid than in the case of hydrochloric acid, which is the only other acid commonly used; is not that some evidence that it is not due to the zinc, but rather due to the acid?—Not necessarily. It points in that direction I admit; but it is not absolutely necessary that that should be so. However, the thing wants testing.

9887. I admit that point wants clearing up. But is it not conceivable that it is, as I put it to Mr. Thomson, the possibility of the formation of sulphuretted hydrogen. Whenever the liquid gets hot when sulphuric acid is used sulphuretted hydrogen is produced in a greater or less quantity. Sulphuretted hydrogen might conceivably keep back the arsenic by forming insoluble sulphide of arsenic?—If you have two similar experiments done with two different lots of zinc, working as nearly as you can tell at the same temperature, with the same size of apparatus, and the same conditions throughout, and the same acid, the zinc only

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different, in one case you can put arsenic in and not get it out by the Marsh test, and in the other case you do get it out. I think it points to the zinc.

9888. That is an experiment you have actually done?—Yes.

9889. You told us that in the case of the beer which had so large a quantity as 1-6th of a grain you were informed that that was brewed from Bostock's glucose?—Yes, I was.

9890. That was a sample of beer brewed in the West Riding, was it?—Brewed in the West Riding, but the sample was sent me from Saltburn.

9891. Do you know what happened to that beer?—Proceedings were taken, but through some technical flaw in the proceedings—it was the first time this authority had taken such proceedings—no fines were inflicted.

9892. Was anything done with the bulk of the beer?—I do not know. I suppose some was thrown out.

9893. Was it recalled or destroyed?—I had samples sent me subsequently from the same neighbourhood, and I did not find arsenic.

9894. So that you think the beer was withdrawn from consumption?—Yes.

9895. You have no knowledge that it was actually destroyed?—No, I do not know, except that I analysed samples from the same district taken by the same authority.

Sulphur and arsenic in fuel compared.

9896. Have you analysed the coke for iron smelters or persons who use coke for foundry purposes?—Chiefly for sulphur. Only since this enquiry arose have I tested for arsenic. Sulphur is considered to be a substance which interferes most with its use in iron manufacture.

9897. I suppose in practice there will be a rough connection between the sulphur and the arsenic?—I think there is in most of these minerals. You will not be far wrong if you estimate arsenic as corresponding roughly to one per cent. of the sulphur.

9898. It comes practically from the mineral which yields the sulphur?—Yes.

9899. Therefore, I suppose that material that iron smelters say should not contain sulphur would presumably be a good form of fuel for the maltster?—Yes, would be better than the ordinary coke.

9900. It is of course a fact that the iron smelter and the person making foundry iron take great pains to use coke as free as possible from sulphur?—Yes, it destroys the quality of the best Yorkshire iron.

9901. Have they very much difficulty in practice in finding suitable cokes?—As a rule, the sulphur does not exist more than about one per cent. in the coke and sometimes less. That is so far as my experience goes.

9902. Of late you have made determinations of arsenic in the same coke in which you have been determining sulphur for the purpose of the iron smelter?—No.

9903. Of late I think you said you had been searching the same coke for arsenic?—No, I did not mean to say that, not identically the same coke.

9904. Can you give us any information from your actual knowledge that the coke which was a suitable coke for an iron smelter by reason of its freedom from sulphur, would be also suitable fuel for a maltster by reason of its freedom from arsenic?—I believe that the more pure it is, the freer it is from sulphur, the freer it will be from arsenic. That is my own belief.

The arsenical kiln dust obtained in Yorkshire.

9905. Those dusts that you analysed from the tiles and walls of a malt kiln were obtained from a Yorkshire malt kiln, were they?—They were from several. They were obtained from two in the Leeds district, and I wrote a circular to a large number of maltsters all over Yorkshire, and offered to make the tests without any expense—and I got a considerable number sent me in that way, and the results which are given in this paper are the results of these tests. Each test is reported there, so that the total number of tests made can be counted up.

9906. I presume this malt would have gone into local consumption?—Certainly.

9907. It went into beer brewed in the neighbourhood of Leeds?—Yes.

9908. The malt which was made in that kiln which contained this dust was used locally?—Yes.

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9909. Would the malt be used to your knowledge in Halifax?—I do not know where the malt would be used, but I know that one of these firms who supplied me with these things—I may say that these samples were given to me in confidence; I was not to publish anything without the consent of the maltsters and brewers who sent me the samples.

9910. You would rather not say?—Not without their permission.

9911. Have you had the opportunity of examining any green malt? Malt before it has been kilned?—No.

9912. (*Dr. Whitelegge.*) Can you say in what form the arsenic was present in the dust that you collected from the walls of the kilns?—Arsenic tri-oxide.

9913. Without further combination, simply as such?—Mainly as such, I think.

9914. Have you any idea what percentage of malt becomes dust. You have spoken about the kiln dust?—This dust corresponds to flue dust from an ordinary fire. It is not derived from the malt itself, but it is adherent.

9915. But the dust removed from the malt in brushing?—That is the culms.

9916. Can you say what proportion it bears to the malt itself?—No, I cannot say from memory; it is a small proportion by weight.

9917. Would it be 1 per cent.?—I should think more than 1 per cent.; but I do not know.

9918. Do you advise the maltsters as to the construction of their kilns?—No, I am not a brewing expert.

9919. But you made certain suggestions about the use of glazed tiles?—Yes.

Importa of clean kilns.

9920. Have you given any other advice of that kind?—To sweep down the walls, clean the place out thoroughly, or else it was no use changing the fuel. They might have these bricks and walls loaded with arsenical dust, which, if a stronger heat current from the fire came on, would shift that arsenic on to the malt.

9921. At the present time are those precautions being observed generally?—I cannot say. I know at least two of the breweries took these precautions to heart, and, as far as I know, carried them out.

9922. You have examined anthracite and fuel generally, have you not?—Only a small number.

Arsenic i Halifax l

9923. (*Chairman.*) To make quite clear a point on which your work has touched on the Halifax inquiry, it has been mentioned in Mr. Hammond Smith's report I have before me that "Dr. Cameron, of Leeds, has lately obtained samples of beer from public-houses belonging to this brewery (that is the Yorkshire Brewery Company), and Mr. Fairley has in two, which do not appear to have been taken with the formalities provided by the Sale of Food and Drugs Act, reported 1-40th of a grain of arsenic per gallon." Is that correct?—Yes, that is so.

Note by Witness to Q. 9876.

The following references on this subject may be useful:—

F. C. Phillips: Chemical News, XLVI., p. 226; Jour. Chem. Soc. Abst., 1883, p. 231.

Noble and others: Lander-Versuchs Stat. XXX., pp. 381-427; Jour. Chem. Soc. Abst., 1884, p. 1,407; Jour. Soc. Chem. Ind., 1885, p. 461; Bied. Centr., XIV., No. 3 Year Book Pharmacy, 1886, p. 146.

Loen: Centr. Blatt. fur Agrik., XIII., p. 68; Jour. Soc Chem. Ind., 1884, p. 327.

Knop: Ann. Aeronom. XI., pp. 418-9, from Bot. Centr., XXII., p. 35; Jour. Chem. Soc. Abst., 1886, p. 172.

Bonilhac: Bull. Soc. Bot. France, Pharm. Jour., 4th Ser., IX. 357; Year Book Pharmacy, 1900, p.

Lettkens: Bied Centr., 1895, XXIV., p. 352; Kgl land, etc., 1894, pp 317-320; Jour. Chem. Soc Abst., 1295, p. 400.

Stoklasa: Bied. Centr., 1896, XXV., p. 353; Jour Chem. Soc Abst., 1896, p. 538.

TWENTY-THIRD DAY.

Friday, 9th May 1902.

AT WESTMINSTER PALACE HOTEL.

PRESENT:

The Right Hon. Sir WILLIAM HART-DYKE (*Chairman*)

Sir WILLIAM CHURCH.
Mr. COSMO BONSOR.
Professor THORPE.
Dr. WHITELEGGE.
Dr. BUCHANAN, *Secretary*.

Mr. FLETCHER MOULTON, K.C., M.P., called; and Examined. [9 May 1902

9924. (*Chairman.*) I believe that from the very commencement of what you have termed in your précis the Manchester scare, the epidemic of arsenical poisoning, you took a very active part in a thorough investigation of the causes?—Yes. I was consulted, I believe, immediately after Mr. Gordon Salamon, and the whole case was put before me by Mr. Groves. The question of what were the proper steps to take was discussed, and when it was decided that a Committee of Experts should be formed, I had the question as to the most suitable members for that Committee put before me. Almost immediately after this discussion, which was between Mr. Gordon Salamon, Mr. Groves, and myself, the members were selected, and we proceeded down to Manchester to investigate the matter on the spot.

9925. I suppose you had a good deal to do, had you not, with the preparation of this report of the Committee of Experts which we received earlier in our proceedings?—Perhaps I may describe what occurred when we first took up the investigation on the spot. It was perfectly clear to us that the mischief was very widely spread, and that the Manchester brewers themselves for the most part were incredulous as to the possibility of there being any serious arsenical poisoning. It was a thing so utterly without precedent that at the time we arrived they believed that something had gone wrong with one particular brewer's product, and they had no appreciation of the extent to which it was common to the whole trade. The consequence was that our first effort was to make the whole of the brewers realise that the mischief was not confined to any one brewer, but that a large number of brewing houses must necessarily be implicated in it, because it came from sugar which was largely used in the neighbourhood. Our object at first was, by means of making the brewers realise the scale of the calamity, to get some measures adopted immediately which would put a stop to all future mischief. At our first two or three meetings in Manchester that which mainly occupied the attention of the members of the Committee (next to this task of putting before the brewers the actual extent of the evil) was to find some measure which would give adequate safety and which could be promptly applied. I wish to put that before the Commission, because in my opinion there never was any vacillation or change of view on the part of the members of the Committee of Experts with regard to the tests to be used or the measures to be adopted. But the problem of finding some immediate step, some test which would be practical and which would prevent future mischief, was a very different task from deciding what should be the precautions to be used in future, when the object was not to stop the possibility of a present danger, but to give absolute security for the future.

9926. You mean there was the emergency part of the question to be dealt with separate from all future security as regards sugar?—Quite so. In the early discussions as to the test to be recommended, and the precautionary measures to be taken, the members of the Committee always kept in mind that these were emergency precautions. I think I am bound also to say that as soon as the brewers had been assembled, and the case had been put to them with great ability by some of the leading men, we had every possible assistance from them. I do not believe myself that from that time any beer was sent out which could possibly cause any mischief—except, perhaps, by accident. I think I remember one case coming before the Courts in which contaminated beer had been sold subsequent to the announcement of the precautionary measures, but it was obviously an isolated case, and due to the confusion between two casks. But substantially, from the time that the brewers became aware of the nature of the calamity, and of what steps ought to be taken by way of precaution, all further evil, I believe, ceased.

9927. The report to which I have alluded was received by us earlier in our proceedings, and has been published. You have kindly forwarded a summary of evidence which you wish to give to the Commission, but I suppose you are aware, are you not, that this summary does deal with a vast amount of information concerning which we have already had very ample evidence?—I understand that.

9928. You would consider it advisable, would you not, that this summary, which has been very carefully prepared, should be printed, and go in with the evidence?—That is entirely according to the opinion of the Commission. Perhaps you will allow me formally, as having been honoured by my colleagues with the position of President of the Committee, to present the final report which the Committee made. That final report came long after the preliminary report, and long after all trouble from the Bostock sugar had ceased. But we very soon came to the conclusion that, although the mischief was substantially due to the Bostock sugar, there was absolutely certainly one other source of arsenic in beer, namely, malt. All other sources seem to me to be capable of producing only infinitesimal quantities of arsenic in beer, but the malt is obviously a very serious question. The Committee resolved that they would not give a final report until there had been a most searching examination of all the materials used in beer, to discover the possibility of arsenical contamination. That part of the work I can speak of, as it was entirely done by my colleagues, and I must say that the amount of careful analysis which was done for the purpose of this report was something quite beyond anything that I should have expected. Later work and final report.

9929. How far is this later report in circulation?—I think it is in circulation only by having been sent to the Manchester Brewers' Central Association. I believe it was printed by the Manchester papers when it was delivered. Perhaps I may formally hand in a copy of the final report. (*Handed in.*)

9930. You mentioned rather emphatically, do you not, in your statement, the question of the possibility of arsenical poisoning through the medium of malt? You say: "On the other hand, I think it is almost certain that arsenical contamination has frequently existed in beer from due precautions not having been taken in selecting coal and coke for malting which is free from arsenical pyrites." You state that with great certainty, do you not?—Yes. Arsenic in malt, and its importance.

9931. Have you anything to say on that point, because that is emphatic language: it might be useful if you

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could enlarge upon it and give the Commission some information of the causes which have led you up to that conclusion?—The evidence of it is the series of analyses referred to in the final report. They point to a very large amount of arsenic in certain portions of malt, in what is called the malt culms, and also a considerable amount of arsenic probably adhering to the skin of the malt. I think that came as a surprise to every one of us, but it undoubtedly arises from the fact that there is arsenic in a great deal of English coal. I remember Sir Edward Frankland produced at the Royal Institution some crystals of arsenic which he had obtained from the air of London, and which he attributed to the burning of the Midland coal in very large quantities, so that the soot contained traces of arsenic. The English method of malting, I understand from Mr. Salamon, differs from that used in some countries in that the direct products of combustion have access to the grain, so that the arsenic which is carried off in them can be deposited on the malt. You will find in that report reference to some specimens of malt which gave quite a considerable amount of arsenic. What made me attach most importance to this was the impression which was made upon my mind, as a mere observer and not a person at all entitled to speak from a medical point of view, by the close resemblance which all the medical men found between the neuritis which characterised this epidemic and alcoholic neuritis which had never been attributed to arsenic; and at the same time the statements that I heard made by other medical men that this particular form of alcoholic neuritis occurred rarely amongst spirit drinkers, and in places where beer was not drunk. Although I should not wish to give any evidence at all on the subject, because the medical side of the Committee was so very strong and so infinitely more capable of forming an opinion than I could be, yet, as an ignorant observer, the proceedings left on my mind a suspicion that arsenic had played a considerable part in what was called the alcoholism produced by beer, and that probably the neuritis associated with it was due to the fact that this contamination in malting had been very common in past years, and that, small as the contamination was, it had in certain constitutions produced morbid effects. That was certainly the impression left upon my mind, and although I feel it is a matter about which individually I have no right to speak, I think it is a suspicion which should not be too completely banished from the mind by theoretical arguments of the smallness of the contamination. There was a circumstance which also made me cling to that suspicion, namely, the peculiar irregularity, so far as the results were concerned, in the connection between the quantity of beer drinking and the arsenical poisoning. There was no doubt in my mind that people who must have taken very large quantities of beer contaminated with arsenic, did not suffer. The peculiarity of this case is that we know accurately when and to what extent the arsenic passed into circulation. We know to a week when the arsenic-tainted sulphuric acid was sent to Messrs. Bostock. They used nothing but that. We know the quantities of sugar they produced; we know the localities where that sugar was used. We have, therefore, for something like nine months the certainty that fairly heavily charged beer was sold. We know the breweries where it was sold. I inquired of the employees of two or three breweries at the time, especially at one from which we obtained very complete information on every point, and I think, with one exception, the employees—although they notoriously drink a good deal of beer, and entirely the beer of their firm—had not suffered. The impression which it gave me was, that the more poorly-fed people suffered rather than the people who were the most alcoholic, and took most beer. There were very many cases of people who obviously took too much beer, but I cannot help thinking from the cases I saw—and I think the doctors will tell you the same—that there were a great number of instances in which there was no evidence of extreme alcoholism. I do not think that want of food had determined the effect entirely. The sort of impression left on my mind was, that constitutional peculiarities make a very great difference in susceptibility to poisoning by these small quantities. If you combine, therefore, the very irregular influence of constitutional peculiarity with the possibility that there has been for years a small contamination due to this difficulty in malting, it may account for this alcoholic neuritis, and I should not be surprised if, now that the attention of the brewing public has been called to it, and malt is no longer allowed to be contaminated, it will make a very great difference in the presence of this alcoholic neuritis which has been so associated with beer. I hope the Commission will quite understand I am only giving them the views of an onlooker, and not of an expert.

9932. And as a listener—of course, you have heard a great deal of discussion among the medical men with whom you were associated?—A very great deal.

9933. You have heard these matters discussed again and again, and that helped you to form this general opinion, which you have given to the Commission, in addition to the other evidence?—Yes, that is so. Our relations were most intimate. I believe I was present at almost the whole of their discussions, and I took a very great interest in them.

9934. With regard to this report which you have formally presented, has any further work or any investigation been carried on by this expert committee since it was issued?—I do not think there has been any analytical work since this report, but if you examine the report and see the number of analyses which have been made for it, you will see that there was very little left to be done. Mr. Gordon Salamon, I understand, is to give some further evidence, and he will probably show the Commission the way in which the analyses were made and tabulated. They form a most extraordinarily interesting body of tests, which in my opinion quite adequately investigate this complicated question.

Brewers the rec mendati of final report.

9935. Are you aware whether the recommendations of this report have been adopted by any brewers' association, or recommended by them to their several members?—Beyond the general recommendation which I should say was implied by the circulation of the report among the members of the Manchester Brewers' Association, I cannot of my own knowledge speak of any. I should fancy that beyond exercising generally more care, the brewers are largely waiting for the result of the present Commission. I think the brewers are exceedingly anxious to have guidance on the matter, but as I have very little to do with brewers except in this particular instance, I cannot of my own knowledge say whether they have adopted this test. I am quite satisfied that the brewing firms are on their guard against arsenic. Let me say that I think there is absolutely no danger lurking on the side of brewing sugars, because the mischief arose not from danger in connection with brewing sugars, but from security, if I may say so. The fact that sulphuric acid is contaminated by arsenic is so widely known that nobody connected with an industry of that kind would ever dream of using sulphuric acid which contained arsenic, and all the firms assured us that they took the greatest precautions. It was, however, so obviously wrong a thing that Messrs. Bostock had fallen into a state of security in imagining that when they bought, as I am quite satisfied they intended to buy, arsenic-free acid, there was no danger of arsenical acid being supplied. And, in my opinion, a scare like this makes it quite impossible that in a chemical industry of that kind such a blunder can be again made. I have much less certainty with regard to malting, because you cannot test your coal as you can test your sulphuric acid, and therefore malting will be rendered safe first by better methods—perhaps the American method—whereby the fumes do not go directly on the malt; or by better tests or better selection of fuel. But with regard to that I think the brewers are likely to have held their hand and waited until this Commission can authoritatively lay down the precautions which they ought to take.

No dang now fro brewing sugars.

Malt les certain

Advanta and lim tions of "guaran

9936. I see there is a recommendation that brewers should make it a rule to require a written guarantee of freedom from arsenic in the purchasing of brewing materials of every kind. With regard to that I should like to ask you what is the real significance of this guarantee which they advised brewers to obtain from the sugar-makers and maltsters. For instance, would such a guarantee in your opinion indemnify the brewer who suffered damage from arsenic in his beer, through the default of the maltster or sugar-maker?—I do not think it will indemnify him. The real good of that is that it dins the word "arsenic" into the persons who are selling the goods. It is too much security which is the source of the danger. And if in connection with the selling of brewing materials there is a guarantee pointing to arsenic, people are always on their guard, and are kept on their guard against it. Nothing is easier than to keep it out. The

danger is forgetting it. The real value to the public of that guarantee would be, that it would be impossible for persons producing brewing materials ever to forget the danger of arsenic. With regard to the indemnity, I do not think it would be an indemnity as against the persons suffering. The persons suffering would be entitled to recover from the brewer, because he had sold them beer which was not good beer; the brewer would then be able to recover from the person who sold bad materials, but the brewer himself would be liable for any consequence of the bad beer he sold, even though he were quite unaware that it contained arsenic.

9937. Then you wish the Commission to understand that if there be any indemnity in the matter it is through an indirect method, and that the security arises through a method of constant advertisement, that there is danger not only with regard to the use of glucose, but especially with regard to the malt in the case of the fuel used?—Yes.

9938. It would be a continual hint to the maltster to secure that his fuel is not only well selected, but well picked over and examined before he uses it?—Yes. I think that that is quite adequate to put an end to the danger, because the danger arises from forgetfulness and carelessness, and not from any inherent difficulty in keeping it pure.

9939. Would you agree that these recommendations in regard to the guarantee might be materially strengthened if official tests were prescribed by the Board of Inland Revenue for brewing ingredients, as recommended in the interim report of this Commission?—I think they would be greatly strengthened, because they would be made intelligible. They would then have a definite interpretation, and if the Board of Inland Revenue could get a test which is practical and easy of application, and gives a substantial security, that would be the greatest service they could possibly render. I do not think an absolute test that was difficult of application would be nearly so useful as a practically sufficient test which could be certainly and easily applied, because I think the danger of rejection is such that the existence of a practical and easily applied, and therefore frequently applied, test would make maltsters adopt methods which would keep their malt perfectly free from arsenic. They would not run the risk of the great loss both to reputation and to pocket which would follow rejection. I think the frequency of the application and its readiness would be very much more serviceable than what you might call its scientific infallibility.

9940. (*Chairman.*) Again, you think that although your method is indirect, it would not afford the less security?—I think it would afford more security.

9941. You think that, after all, the result in regard to the security would be good?—I think it would be practically certain. With regard to this I think there is no evidence before us at all of the existence even in this case of any beer which produced evil effects otherwise than by repeated drinking. The toxic character of the beer never rose to such a point that once drinking would produce any result. So that you always have this to be relied upon, that it has to be a course of immunity from detection which could allow anything which would hurt the public; therefore a practical and frequently applied test would, in my opinion, give almost certain protection.

9942. Do you agree then that a standard test which should entail the condemnation of arsenical beer should be fixed for the purposes of the Food and Drugs Act?—Yes, but I suggest that tests should be prescribed higher up the scale than that with regard to the brewing material, because the investigation of the beer is a little late. You want to have something which brewers know is a sufficient protection to them; that if they will apply it they cannot be accused of negligence. Then if it is an easy and satisfactory test it will be applied, and what is more it will be applied by the producers themselves; and no method which yields a malt which will not pass that test will in the future be adopted. If there is a discussion as to what is an adequate test, if there is nothing authoritative, then the maltsters are not themselves scientific enough to take judicious action; but if they have something which they have to live up to, they will take care they have no methods which do not give them a malt which will stand that test.

9943. Can you suggest an authority which should have the duties of watching over the purity of the articles of food and drink also—that they should know the conditions of food manufacture and prescribe standards for reference by duly appointed public analysts?—Of course it must be the Board of Inland Revenue. I think the most important thing is that this Commission, either by appealing to the Board of Inland Revenue, or to some other high authority, should state what they think is adequate and practical in the way of watchfulness on the part of the producers. Then the ordinary powers of public analysts under the existing statutes would enable them to test beer or brewing materials. I think brewing materials should certainly come for this purpose under the class of food. I do not remember the definition; I do not quite know whether they do so now.

9944. (*Professor Thorpe.*) They come under the Act of 1899: anything which enters into the composition of food is *ipso facto* food?—I am obliged to you for that. That is just what I was doubtful about. I had forgotten whether there was a definition clause to that effect. It is much more important that people should know what they have to live up to than that there should be a vague duty of their products being absolutely pure. I think the latter leads to very costly and very difficult litigation, whereas if purity means being up to a particular standard, tested in a particular way, much of that would be avoided, and the results to the public would be very admirable.

9945. (*Chairman.*) Are you aware that the Departmental Committee on Food Preservatives recommended the appointment of an official court of reference for this purpose? Have you anything to say upon that?—I am afraid I am not very fond—if I may use a phrase which you have heard during the last few days—of "Courts *ad hoc*." I cannot help thinking that it is difficult to get good Courts—and as we have good Courts in our judicial system I should prefer to leave it to the existing Courts. But the definition of duty I think should be a practical one.

The duty of manufacturers should be defined.

9946. Have you any other suggestions to make which strike you at this moment which would give greater security against arsenical poisoning. Have you any general observations to make?—No, I have not. I think the important thing is by making it almost a duty of brewers to get these certificates with regard to their brewing materials, to keep the danger before the minds of the whole trade, including all the producers. Advice ought to be given to enable them to know when they are safe; that is to say they should be told what are reliable and good practical tests, and then I think the danger will cease. I do not think it ought to be made at all a statutory duty to require a warranty. I do not think that is the way to do it. The proper way is to say that you think it would be an act of great carelessness for a brewer to buy without it. That is quite sufficient; if you are going to say that it is the statutory duty there may be a great number of questions as to what comes within the meaning of the word warranty, and it becomes a technical question; but if you put it that a man who has a sufficient conception of his responsibilities would not, in the opinion of the Commission, act otherwise, that would have a more wide-reaching effect than putting upon him a statutory duty. For instance, supposing a man did not do it; he would know that if any trouble came he had neglected to do it at his peril, and that would have a really wider effect, and at the same time it would be less onerous and less technical than if it was embodied in legislation and made a statutory duty. I think the greatest kindess that this Commission can do to the public, and especially to the trade, is to state what they think is the duty of a person aware of his responsibilities, and to state in detail how, in their opinion, he can adequately discharge that duty.

9947. (*Sir William Church.*) Did the Expert Committee obtain any evidence or statistics with regard to the frequency of so-called alcoholic neuritis in any of the large centres of population?—I do not think they obtained statistics, but I know they discussed it a good deal. We were brought into contact with many medical men, and I know for my own part—and I believe I may speak on the part of the medical portion of the Committee—that the question was raised very frequently as to whether alcoholic neuritis was equally common in large centres of population where beer was not drunk. For instance, I remember Glasgow being spoken of.

9948. I mean where beer is drunk, because the impression left upon my mind—and I think upon the

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minds of the other members of the Commission—was that there was a very large discrepancy between the comparative numbers of those suffering from so-called alcoholic neuritis in the Manchester and Liverpool districts, and in the metropolis, or in Scotland?—I think I remember learning that during the process of the Commission, but why I am rather disinclined to say positively that I did do so is because I remember that in the subsequent investigations we found that the southern malts were much freer from arsenic than the northern, and I should be a little bit afraid lest I had unconsciously allowed my belief as to the distribution of neuritis to be influenced by that fact. I think we found that out, but I will not be perfectly sure.

More arsenic in northern malts.

9949. I asked you that because to my mind now one of the important things before the Commission is to see whether there is evidence that malt made without due care as to the fuel used in drying it, has been in the past prejudicial, and therefore would be likely to be prejudicial in the future. That seems to me now to be the most important part of our duty almost, because it is clear that the outbreak of actual poisoning was due to what may be accidental causes?—Mr. Gordon Salaman probably knows as much as anyone about the distribution of the malt made in different parts of the country among the brewers. Unquestionably we came to the conclusion that the southern malts were more free from arsenic than the northern malts, and if it could be shown that the places where the northern malts were largely used were more liable to alcoholic neuritis, it would have the greatest influence in pointing towards the arsenic in malt being a cause of the prevalence of this disease.

Difficulty of controlling arsenic in fuel by analysis.

9950. (*Dr. Whitelegge.*) You said that coal could not be tested like sulphuric acid?—Yes.

9951. What sort of practical difficulty have you in your mind as regards coal?—In this way. Pyrites is so patchy. You may test a coal and forbid it, and you may test a coal and accept it; but you have to accept it as a class of coal. You cannot satisfactorily test a particular parcel of coal. In the case of sulphuric acid you may test a cargo with certainty, but you cannot test a cargo of coal, because the occurrence of the arsenical pyrites is not uniform throughout.

9952. So that you have no guarantee of a proper adequate sample?—No, that is what I meant.

9953. You said, if I remember rightly, that you wished to have standards not only for finished beer but for beer ingredients?—Yes, standards defined by tests.

Application of Food and Drugs Acts to beer ingredients.

9954. And that these should be available not only for any purpose that the Board of Inland Revenue might desire, but also for the purpose of the Sale of Food and Drugs Acts?—Yes, in this sense that I think the Commission should state that the articles should answer such and such a test, and then I think that if they get beyond that they would naturally come under the Sale of Food and Drugs Acts.

9955. The evidence we have had from the representatives of local authorities points to some doubt in their minds whether they can apply the Sale of Food and Drugs Acts to wholesale supplies, and particularly those which are sold for the purpose of manufacture. In the case of brewing materials, would you think it right that the standard for the purpose of the Sale of Food and Drugs Acts should be applicable to the manufacture of a brewing ingredient sold wholesale and not to the consumer?—I think it should; but may I say I think the existence of these tests would make the brewer himself the person in fear of whom the manufacturer lived. The responsibility it would throw on the brewer, the knowledge of the danger and the knowledge of the test which he ought to expect his materials to answer, would make him the person to whom the manufacturer would be liable. All you want is to impress the manufacturer with the need of care, because a manufacturer on a large scale never need allow these things to occur. It is not a question of allowing casual contamination of a particular parcel or anything of that kind. If he knows what is going to be the definition of his duty before his customers and before the world, he will naturally arrange his method of production, and live up to it.

9956. That would be quite true, no doubt, in the case of many brewers. Do you think the same principle could be fairly extended to the manufacture of substances intended for food but not for beer?—Most emphatically. I think it should be a general principle.

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Nature of tests advocated.

9957. (*Professor Thorpe.*) The only point I should like to ask about is in order to clear up some doubt in my mind as to precisely what you mean in suggesting that something like tests should be laid down by the Board of Inland Revenue or some other authority, and that these tests in the first instance should be thoroughly practical tests and easy of application. Have you in your mind that those tests should be applied by the maltster or by the brewer in the first instance?—I think they ought to be capable of it.

9958. Is it your opinion that they ought to be such that a man without any technical or expert knowledge of chemical manipulation could apply them?—I do not know whether you have ever seen the way in which men at sea will reckon lunar distances—a very complicated and difficult thing for a mathematician to do, but which they get accustomed to do as a rule of thumb—and although they are guiltless of the faintest understanding of the process through which they go, they will calculate with very considerable accuracy where they are by this recondite method. In the same way I think that with care a test which is quite adequately rigorous might be devised, and the means of carrying it out might be defined so that people, with no more education than I trust we shall have soon among those concerned, will be able to apply it.

9959. I venture to say there are no chemical tests which cannot be reduced to that kind of rule of thumb procedure, and that the most delicate determinations you like to make are susceptible of that kind of definition and application?—I think that is a thing to be distinctly considered in defining a test.

9960. That clears up one part of my doubt, because it struck me that if you had in your mind something of the nature of a rough-and-ready test, and that a non-expert unaccustomed to chemical manipulation should use that test, he would certainly in his finished beer be judged by a much more stringent test when that beer passed through the hands of the public analyst?—I do not deny the value of what I may call an exploratory test of a rough kind which might be done quite readily, but I think the great point is to have a test which could be applied in the way I say—which would be pretty well a definition of duty. I do not believe in the theory that the duty of purity is to be limitless, that traces which improved chemistry can find are sufficient to make a thing impure. I think that in all these things what you want is something which gives practically adequate results, and its applicability is much more important than rigorous accuracy.

9961. The difficulty to my mind is this: you invite the Commission or some other authority to lay down a test which is susceptible of application by what I may call a practical man, the brewer or the maltster. We know, of course, he will not ultimately necessarily be judged as regards the finished product by a test of that exploratory or tentative character; he will be judged by something more stringent?—I think that the stringent test should also be formulated, and should be of a kind which could be applied by a practical man—I mean after proper training. I think it most important. You may give an exploratory test, only meant to be, as it were, additional, in order that a person might at any moment see that things were not going very much wrong; but I think that whatever test you take of purity should be a test that all live up to. I do not believe in testing a man when he comes into court by something you do not expect him to live up to in practice. I think it is much more important that you should have a reasonable severity in your test, and that the test should be one which could be applied.

9962. Both by the analyst and the practical man?—Yes.

9963. That settles my point, because I see a little difficulty in prescribing or giving official sanction to what is called an exploratory test, the man being afterwards liable to be judged by something which may be more stringent; he lives under a sense of false security?—Exactly. An exploratory test would be simply of the nature that it may give a warning, but the other must be a test of his duty.

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9964. (*Chairman.*) You have forwarded us a very ample document concerning matters upon which I believe you are prepared to be examined. I see on the first page of your *précis* you mention "that in consultation with some of the leading authorities in Manchester it was agreed that all danger of further poisoning would be stopped if the amount of arsenic (calculated as arsenious oxide) did not exceed 1-50th of a grain per gallon of beer." Is it your opinion that anything below 1-50th grain may be considered in every case as a negligible quantity?—I cannot speak as a medical man on that point. When we were at Manchester in consultation with the medical authorities they came to the conclusion that 1-20th of a grain per gallon was a dangerous quantity, and that anything less than 1-50th of a grain per gallon so far as poisoning was concerned—that is, poisoning in the sense of producing quick results—could be regarded as negligible. Those were our instructions in Manchester. We had to keep to a limit of less than 1-50th of a grain per gallon, and then we were regarded as safe. That was what we endeavoured to do in working out the tests.

9965 (*Professor Thorpe.*) That really was under an emergency?—Clearly. At that time we did not know of the existence of traces of arsenic in malt—no one knew it. We had to find out how it was at a later period that these beers would not pass the test we gave them, and that led us and others to the discovery of traces of arsenic in malt.

9966. But looking at it from our present point of view, do you consider that 1-50th of a grain is where the line should be drawn?—No, I do not. I think it ought to be a stricter line than that. It is very difficult to define the limits. It would be better to exact precautions which would ensure safety all round. I can say, however, that a brewer can well work within 1-150th of a grain per gallon now that we know what precautions should be taken.

9967. There is no necessity for the beer to contain more than one-hundredth of a grain per gallon?—I think not. I should say that beer, as brewed to-day, does not contain anything like that quantity as an average; in fact, I am in a position to assert that it does not. There are a few cases where beer does contain more, but they are very rare.

9968 (*Chairman.*) In paragraph 12 of your *précis*, referring to this great question of tests and their application, you say that for use by skilled chemists you favour, and always have favoured, the use of the Marsh-Berzelius test. Would you amplify that, and give us some reasons why you so favour this test?—The question of arsenic testing by the Reinsch or the Marsh-Berzelius test was elaborately considered by the Committee appointed by the French Academy of Science, of which I think the great chemist Regnault was the reporter, and it was further elaborately examined by that great expert in toxicology, Gautier, and both these investigations pointed to the conclusion that the Marsh-Berzelius test was undoubtedly the best if properly applied. But they also pointed to this, that in order properly to apply the Marsh-Berzelius test it was necessary that the precautions taken should be of an ultra-refined character; and unless those precautions are adopted to-day, I should prefer the Reinsch test to the Marsh-Berzelius test. But if those precautions are adopted, then I greatly prefer the Marsh-Berzelius test to the Reinsch test. Again, the report of the Joint Committee of the Society of Chemical Industry and the Society of Public Analysts has even further refined the precautions necessary to be taken. Therefore when we come to discuss what Mr. Fletcher Moulton has called an exploratory test, I cannot help thinking that the Marsh-Berzelius test is quite unsuited to be placed in the hands of an ordinary manipulator, such as one would find in a small brewery. And I would venture to point out to the Commission that it is very necessary to cater in these cases for the small brewer and for the brewer of comparatively small means, rather than for the large brewer, the important brewer, who keeps his chemist upon his brewery, or who engages a professional analyst; because in the future the larger brewer will, as he is doing to-day, take every possible precaution to prevent his raw materials being contaminated with arsenic. But the small brewer, who has to compete against the large brewer, and who has often seriously to compete in prices, will be tempted by cheap material, which is possibly impure. I know, for instance, that much of the malt which was made with gas coke was offered to the large brewers and refused, because it contained more arsenic than is now considered desirable; and I know that that malt has been taken up by the smaller brewers because it was offered at a cheaper price. It has now been worked off, and I do not suppose we shall have any more of it. But I do suggest that the Commission ought to approve of a test which would enable the small maltster or the small brewer to be sure that what he was sending out was free from arsenic. I do not consider that the Marsh-Benzelius test would enable him to do that in practice, but I do consider that a proper application of the Reinsch test would enable him to do it.

Reinsch test recommended for unskilled use.

9969. When you say that, do you mean that because the first test is far more difficult of application? You describe here two tests, the Marsh-Berzelius, and what you call the rough-and-ready Reinsch test. You wish us to understand that one is more easy of application than the other?—I do, that is my point. I should like to show these tests to the Commission. I found by the Marsh-Berzelius test 1-140th of a grain of arsenious acid per lb. of malt. I applied the Reinsch test upon the same quantity of the same malt, and I immediately obtained the blackened copper. That proved to me that the Reinsch test, which is easy of application, would put the malister upon the *qui vive*, and show him that even in the case of 1-140th grain to the lb. of malt, it would give him a test which he could readily apply to every sample of malt he sent out. I suggest, however, that that would not be the case with the other test.

9970. (*Mr. Cosmo Bonsor.*) What would 1-140th of a grain to the lb. of malt mean in a gallon of beer?—It would be less than 1-70th of a grain, because you have to count the amount taken out by the yeast, and that is a very important factor. There is considerable elimination during the process of brewing. This is, therefore, a very delicate test, and one very easy of application. I do not suggest it as an official test, but I suggest it as a test which may be used for the purpose of manufacture.

9971. (*Chairman.*) You mean that it would be the first hint that there was something wrong?—Quite so.

9972. Supposing this were done, and a dangerous state of things existed, it would not protect the brewer, if any liability were thrown upon him, from a further analysis by a Government official?—Dr. Thorpe will know that in sulphuric acid works the ordinary testing for arsenic in the process of manufacture would probably be conducted by a lad, and would not generally be made by the Marsh-Berzelius test, but upon a rougher test; but tests connected with the subsequent deliveries of the finished acid would be made upon the Marsh-Berzelius test. In the one case there would be a rough test for the purpose of the factory, and in the other there would be the refined test, which would give very great accuracy.

9973. (*Professor Thorpe.*) I am sorry to say I cannot agree with that statement. I know that the exact opposite is now the case. I know in sulphuric acid works that before the oil of vitriol is sent out the Marsh-Berzelius test is applied?—Yes, on the finished product. I was speaking of the process in the course of manufacture, in order to see whether the elimination was complete, and I happen to know that the Marsh Berzelius test is not applied in those cases; at least, I know works where it has not been applied. I have seen the tin test and the Gutzeit test employed. In any case it illustrates my point, and that is why I gave it as an example. I should like to add also that it would have been absolutely impossible for us to have stopped the spread of the epidemic in Manchester in the time we did had we been wholly dependent upon the Marsh-Berzelius test, in which test, be it understood, I thoroughly believe. We could not have applied it with sufficient rapidity, and we could not have placed it in the hands of a sufficient number of men in time to have made all the tests which were necessary in order to deal with the matter quickly.

Government Laboratory control over beer advocated.

9974. (*Chairman.*) In your *précis* you say that you are of opinion that much benefit would result from periodic testings for arsenic in beer being made at the Government laboratory upon the samples taken from all the breweries throughout the country?—I think it is most important that that should be taken in hand if it be practicable.

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9975. Do you mean to say that this process should go on to the exclusion of control by public analysts?—No, I do not. I rather had in my mind when making that suggestion that if the Government authorities were, through the Inland Revenue, to make periodic tests, they should inform the brewer that they were taking those samples for the purpose of arsenical testing, and that the brewer should, in every case, be informed as to the result. If the Government authorities found that there was an amount of arsenic in those samples which was pointing towards the agreed limits, they would, I take it, in their discretion inform the brewer, and very quickly again take samples. If they then found a dangerous amount, after having warned him, I take it they would communicate with the local authorities, who would take action. The result of that would be that the brewer, and particularly the small brewer, would know that he was constantly under the possibility of control, and he would be on the *qui vive* as to what materials he employed.

Gas coke should be prohibited or malting

9976. You deal here with the question of fuel and the use of gas coke; do you still hold to the opinion expressed in the Expert Committee's final report that the use of gas coke should be prohibited altogether in the process of malting?—I do, strongly. My experience is that there is no necessity to use gas coke at all, and even that there is no necessity to use coke at all in the making of good malt. The best maltsters do not use it. Gas coke is used solely for the purpose of economy. Now, that it has been established that it is a source of possible danger, I do not think its use ought to be permitted in the making of malt, and I am quite sure that no respectable brewer desires that it should be employed.

9977. Do you think it is being used to any great extent now for malting purposes, or has this late scare led to its exclusion?—I think the late scare must have largely led to its exclusion. My analyses show within the last six months that the amount of arsenic in malt, even by way of trace, has very materially diminished; and I am quite sure that that is very largely due, perhaps wholly, to the elimination of gas coke in the manufacture of malt.

9978. (*Mr. Cosmo Bonsor.*) The price of coal has gone up, has it not, and the price of coke down?—Yes, I believe so.

even if lined.

9979. (*Chairman.*) With regard to the fixing of arsenic in gas coke by the use of lime, you think that is a process which had better not be adopted? You think it would be better altogether to prohibit the use of gas coke than allow it to be used?—Personally, I think that the process for fixing the arsenic by lime is good, and if the process is properly applied I think it is reliable. But the Commission has to deal with the possibilities of negligence, and if the lime is not properly applied in the fixing of arsenic, then it may be of no value whatever. The difference which the use of gas coke would make in the price of a quarter of malt is so small that I think it would be well to eradicate the possibility of contaminating the food with the poison; and for that reason I should be inclined to say that it would be far better to prohibit the use of gas coke than to allow it to be doctored with a material which might not be properly applied from time to time.

9980. Have you anything to add with regard to your statement about the roasting of malt? You mentioned that out of 53 samples so dealt with, only one was found to contain arsenic, and that a very minute trace?—It points to the fact that the contamination of malt by arsenic comes from the products of combustion, because the malt is roasted without those products being passed over it; but I do not think it would be possible, or practicable, at any rate, to-day, to produce a malt suitable for the production of our present ales by the application of radiant heat to the malt. I do not think that you could eliminate the effect which the products of combustion have upon the malt in curing, any more than you could cure a ham by radiant heat and get the same flavour in it as you do by the way in which it is cured to-day. I think the flavour of malt, and subsequently of the beer, is very largely influenced by the passage of those fumes through the malt itself. Again, if you were to attempt to heat by radiant heat—it may come perhaps some day—the interference with the trade would be enormous. It would mean the reconstruction of practically every malting kiln in the country, and I do not think that is practicable.

Flavour of fumes essential to malt.

Alteration o kilns means enormous interference with trade.

9981. With regard to anthracite, you state very truly that it may contain pyrites, but when you mention that it is to be selected, is there any special process through which you think it should be put beyond picking it over by hand?—Have you any suggestion to make with regard to that?—I should like to point out that those two samples, the tests of which I handed to the Commission, were prepared from anthracite. The samples were sent to me quite recently by a very intelligent maltster, a man who desires to produce the best article, and he told me that they were prepared from the best anthracite. I think it would be interesting to the Commission if I privately handed in the letter which I received from him, as it shows that arsenic may be introduced into malt in infinitesimal quantities even from anthracite. The whole question, of course, is the selection of the anthracite by means of hand-picking and washing, so as to eliminate the pyrites. (*The Witness handed in the letter.*)

Arsenic in anthracite dried mal

9982. The tests showed 1-140th of a grain?—Yes. The sample was sent by the maltster for the purpose of his own information. He sent it to me in my professional capacity in order to examine for arsenic.

9983. It is a fact, is it not, that certain collieries, or certain seams of anthracite in certain collieries, contain less pyrites than others, and that some have a better name for purity?—I believe that is the case.

9984. Therefore it would be an extra security if the maltsters were to apply to collieries for their materials which were known to be more pure with regard to pyrites?—It is a question of selection. I do not know if it would be practicable for the maltster to attempt to analyse his fuel, because the very difficult question of sampling comes in. The maltster can make periodic analyses, and they will be worth something, but he could not be expected to analyse every delivery of fuel—it would not be practicable. He could not sample it, even if he could analyse it.

Difficulty systemati analysis o fuel.

9985. (*Mr. Cosmo Bonsor.*) With regard to the letter which you have handed in, are you aware whether that maltster used to use coke?—I do not think he ever used it—I remember him telling me he never used it.

9986. I asked you because I know of instances where coke used to be used in a malting house. This year anthracite was used, but traces of arsenic were found in the malt. The presumption was that the arsenic had lodged in the kiln, and had been blown into the malt when the draught came?—That is quite reasonable, but I do not think it could have occurred in the case I have referred to, because I remember the maltster told me that he had never used coke.

9987. (*Chairman.*) You consider that cleanliness throughout the malt kiln and throughout every process is absolutely necessary?—Yes. I have found in my investigations that the malt culms have a particularly preferential power of taking up and absorbing arsenic. I think it is very necessary that the kilns should be cleaned out more often, because the culms that drop through would give a fresh absorbing couch of culms.

Arsenic i kiln dust.

9988. Cases have been adduced before us in evidence in which a very considerable amount of arsenic has been found in some malt dust which had been a long while collecting. That points, does it not, to the necessity for extreme cleanliness, so as to avoid the collection of any old malt dust in large quantities?—Quite so. In the case of dust which I examined, where gas coke had been employed, the amount of arsenic was really very considerable. But I feel so strongly upon the necessity of not allowing gas coke to be employed, that I would suggest the desirability of making it penal to employ gas coke in the preparation of malt, regarding malt in the light of a food product.

Governme Laboratory control.

9989. You refer here to analyses in the Government Laboratory which would effectively, in your opinion, control the operations of the maltster—you referred there to the analysis of beer, I presume?—Yes, because if the Government analyses were found to be unfavourable to the brewer he would, of course, for his own protection, trace it back, and unless he could trace it to the employment of any other material that was injurious, he would throw it back upon the maltster, and examine the malts, so that it would effectually control him.

9990. Do not you think the recommendation of the Comission that the Government Laboratory check should be applied to the malt itself, would be a good safeguard?—It would be scarcely practicable for them to do it upon every delivery, but if they were to control

the beer, or even the yeast, it would be better, because it would be a more sensitive control in the brewery, and they would then be easily able to keep it in check. They have not so much control over the malt kilns as they have over the breweries. There they have access to all parts, and everything would be organised for their taking the samples, but I do not think, subject to correction, they would have the same facilities in connection with malt kilns.

9991. (*Professor Thorpe.*) Might I suggest that the practical way would be to examine the wort, because it is part of our duty to collect the wort; we do that?—I agree, subject to this, that as you know the wort does not constitute in all cases the final beer as it leaves the brewery, because ready-made beer is frequently added to it in connection with returns, and so forth. I do not think the wort would quite control the problem so as to actually and adequately safeguard it. I think the beer itself would thoroughly control it, but I am not quite sure that the wort would.

9992. But even the beer that is added must have been wort at some time?—Yes, but you do not know where it has been since.

9993. Of course we should have to obtain fresh powers to check the beer in that sense, but now it is part of our duty to check the worts, and worts constantly come to the Government laboratory as a matter of official routine?—I think it would go a very great way if you were to work upon the worts, but to make it quite satisfactory I do think additional powers should be given to you to take these samples of beers.

9994. (*Chairman.*) You have handed us in a summary of analyses since January, 1901. You show there a great improvement in the malt samples sent to you by brewers since October, 1901. Have you anything further to state to the Commission with regard to these analyses?—I believe you are responsible for each and all of them?—Yes, they have all been done in my laboratory, and they represent many hundreds of samples. I would like to point out that from January to April of 1901 I found 70 per cent. of the samples free from arsenic; 3 per cent. contained under 1-300th of a grain to the pound, 19 per cent. contained above 1-300th and under 1-150th of a grain per pound. Then there were 8 per cent. of what one might term, speaking of traces, notable quantities, that would be above 1-150th but under 1-20th. Then from the period of May to September in that year there were 43.4 per cent. free from arsenic, 2.6 per cent. contained more than 1-700th of a grain per pound, but less than 1-300th; 38.5 per cent. contained from 1-300th to 1-100th of a grain per pound, and 15.4 per cent. contained over 1-100th and not exceeding 1-28th of a grain per pound. It must be remembered that the malt, of which I have given these results was substantially the malt that was made during the season of the epidemic, and it had not then been pointed out that gas coke was injurious. These were in all cases malts from all parts of the country—from Yorkshire, Lancashire, and from all parts.

9995. Chiefly the north?—No, all parts of the country. Then we come to the period as from October, 1901, when the new malting commenced, to March, 1902. That would cover the new malt. There we find a vast improvement in the elimination of these traces of arsenic. There are 34 per cent. free from arsenic; 25 per cent. contained under 1-700th of a grain, 19 per cent. contained about 1-700th of a grain, 13 per cent. contained about 1-350th, 6 per cent. contained above 1-300th and under 1-100th of a grain per lb., and 3 per cent. only contained above 1-100th and under 1-27th of a grain, so that there was substantially 97 per cent. of the malt which I examined during that period which would not have imparted to the beer a sufficiency of arsenic to have been regarded, according to the present limits, as even an appreciable trace. I think that shows a very highly satisfactory state of things, and shows that the use of gas coke has substantially ceased.

9996. Are you prepared to state to the Commission your belief that in a great measure this change was due to the cessation of the use of gas coke in malting?—I do state that; I believe it to be so, and probably also by increased cleanliness in the kiln—that is to say, the dust in the kiln was more frequently removed. That, coupled with the discontinuance of the use of gas coke, is, to my mind, the explanation of that vastly improved state of affairs.

9997. This statement is not based altogether upon inference, but on knowledge?—From knowledge within my own experience. I know that maltsters have given up using gas coke.

9998. Therefore, you state that as definite information?—Yes, as regards my own experience.

Arsenic-free sulphuric acid should be used not only for food purposes but for manures.

9999. With regard to the point you mention here in your *précis* of the desirability of considering whether the use of arsenic-free sulphuric acid should not only be made compulsory for food purposes, but also should be extended to the preparation of artificial manures, have you anything to say upon that point? For instance, can you adduce before us any concrete instances in which you are aware of arsenic having been communicated to barley or other grain?—I have examined some samples. You will find in the report of the Committee that samples of barley do sometimes contain minute quantities of arsenic. Fourteen samples of typical malting barley, we say, grown in different parts of the country, were submitted to analysis, and five out of the fourteen contained minute quantities of arsenic, and one sample of unkilned barley—of course, you must deal with unkilned, otherwise it may have been contaminated on the kiln—contained 1-400th of a grain of arsenious acid per lb. I think it is clear that barley is liable to contain very minute quantities of arsenic from the fertilised soil of arsenicated manure. But it will be within the recollection of the Commission that Mr. Weld Blundell gave evidence respecting what he thought was contamination of root crops and roots, through arsenical manure. I believe that the gentleman is dead, otherwise he was to have appeared again before the Commission. He sent me some of the roots that he had collected to examine. I examined them, and I found most unmistakable traces of arsenic in those roots which the sheep had been feeding upon.

Arsenic in roots.

10000. What were the roots—swedes or mangolds?—Swedes.

10001. When you say unmistakable quantities of arsenic, what quantity do you mean?—I have not the tests with me, but, speaking from memory, it would be something like the same as we found in the barley—about 1-400th of a grain per lb. It was within the region of that quantity.

10002. When you refer to these roots, are you referring only to the letter of Mr. Blundell?—He sent me the samples.

10003. Did you yourself test those roots?—I did.

10004. He says at the end of the letter: "The season is too far advanced to allow of any examination of roots to make any experiment"?—Yes. He was just in time to get some, and able to send them to me.

and barley.

10005. But what percentage of arsenic was found in this barley you mention?—The barley was about 1-400th of a grain to the lb., and I should say that the amount in the roots was about the same.

10006. It was entirely a negligible quantity in each case?—Quite so.

Kind of official test recommended.

10007. You say in your *précis* that if the Marsh test is adopted as the official test, as you consider it should be, the standard then should be officially issued, so as to avoid discrepancies with regard to the results. Will you explain a little more to the Commission what you mean on this point?—I was assuming that an official test would be devised and laid down. I have had the advantage of seeing some of the tubes that Mr. Thomson had prepared. Everyone knows the immense amount of care that he has taken with his arsenic work, and the extreme ability with which he has conducted it. I have tried to be careful with my work, too, and yet I was amazed to find that Mr. Thomson's tubes were of an entirely different calibre to mine, and that the manner in which he collected his arsenic on the mirror was quite different from mine. I had devised this form of standard to test my tubes with. (*Handed in.*) I find that he had his of a different diameter altogether. That brought me to this, that it seemed to me that the Commission ought to lay down a form of standard test which would prevent one analyst giving 1-33rd of a grain, and another analyst 1-300th of a grain, as I believe has been the case. I thought it would help to secure that if the Commission would devise a permanent standard print of colour as representing a certain percentage of arsenious acid, if the permanency of those colours could be secured. The mirrors in the tubes do not keep permanent in light, as Dr. Thorpe will know,

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but if they could be printed in some permanent form, and then circulated by authority, they would serve as standard tests which, in the case of a prosecution, would ensure uniformity of result being obtained by different chemists. That was the point that occurred to me as being necessary. It was a matter that would want studying out, so as to get the proper fixation of the colouring. Then, also, they would be able to give the proper dimensions of tube, and other details of the apparatus, and that would be shown on the plan they would send out, which would be accompanied with a minute description of how the test had best be made.

(*Professor Thorpe.*) I do not think there would be any difficulty in that.

10008. (*Chairman.*) I do not know whether you have read the interim report in which the Commissioners said: "We have evidence that at the present moment analysts are by no means agreed as to the best official test to detect minute quantities of arsenic in beer. In view of these circumstances, we consider it essential to institute further inquiries before recommending the standard test that should be imposed." You understand that the Commission has considered this as an all-important point, and one on which we, of course, have to hear and seriously consider further evidence?—Yes. Those standards I have handed in are made with magnesium, because I could not get arsenic-free zinc at the time. They would not be quite the same as the zinc mirrors. I have noticed that the mirror is not quite the same. There are some small points of that kind which it seems to me require to be cleared up by the Commission, so that uniformity may be obtained.

Should be penal to use acid for food purposes which is not arsenic-free.

10009. There is a paragraph in your statement which says: "The extra cost of purifying the pyritic acid so as to make it arsenic-free within the limits of infinitesimal traces, would not, according to the inquiries of witness, exceed 3s. to 4s. per ton of 70 per cent. oil of vitriol." I would like you to go into that subject a little?—Personally I suggest that the sulphuric acid which is required for the preparation of foodstuffs and for pharmaceutical purposes ought to be commercially free from arsenic, and I suggest that it ought to be made penal to employ for those purposes sulphuric acid which is not commercially free from arsenic. The cost of purifying sulphuric acid from arsenic is not more than from 3s. to 4s. per ton of 70 per cent. oil of vitriol, and the public certainly would not, I consider, feel the extra cost of that acid, and they would be safeguarded to a very great extent; because although to-day guarantees are given of purity, still there might be an accident, and if it were prohibited under a penal offence to employ any but arsenic-free acid for the purpose of medicinal preparations and foodstuffs, it would not hurt the manufacturer, it would not hurt the public, but it would be a very great security. The extra cost involved is so small that I believe the manufacturer would readily be able to do this. And I would point out, as Dr. Thorpe will well know, that there is not a manufacturer of sulphuric acid who has not to hand the means of taking out the arsenic, either by the new catalytic process, or by the old method of arsenic purification. It is a method which he could easily carry out. It is a horror to think of the possibility of the recurrence of a delivery such as was made from Messrs. Nicholson's works to Messrs. Bostock, and I think it could be largely obviated by dealing with it in the manner I suggest.

10010. (*Sir William Church.*) Among these samples of malt that you found were free from arsenic altogether, could you tell the Commission whether the majority of them came from the south or the north? You say they came from all parts of England?—I should say they were very evenly divided; they came from all parts of the country. I am able to say that, because a number of brewers have now insisted that all their samples shall be examined by way of advance samples, and the maltsters have to send them to me for these breweries I represent before they are passsd by the brewery, before they are delivered in bulk to the brewery, and then they control that afterwards by further tests from the bulk deliveries themselves. Therefore I happen to know that these do come from all parts of the country. It is not that the brewer merely sends it to me to see whether it is free from arsenic or not, in which case I should not know where it came from; but I do know because of the advance samples being sent to me. Therefore I can say that they fairly represent the malts throughout the country.

Mr. A. G. Stevenson.

9 May 1902.

Affinity of culms for arsenic.

10011. You made use of an expression with regard to malt culms, that they seem to have an affinity for arsenic. I suppose that is only because of the open mesh-work through which the currents of air pass; they cannot pass through the solid body of malt?—I think there is a physical reason, and I am largely inclined to the belief that there is also a chemical reason. I think it is very much on the same lines as the greater absorption—the preferential absorption—of arsenic by yeast. I believe that certain albumoses have the power of forming definite compounds with arsenic, and I have some slight experimental data already in that direction. I would not like to put it forward as conclusive or exact, but if you ask me if it is solely physical, I do not think it is. I think there is a chemical reason as well as a physical reason for the greater absorption of arsenic by malt culms and also by yeast. I think the two are on all-fours.

10012. I presume that when the green malt is placed upon the kiln it is only for a very short time that anything like vital action can be going on in it; it would so soon be killed by the heat?—Yes, but for some considerable time the amount of air is very large in proportion to the products of combustion. The endeavour of a maltster who does not hurry his work too much, and does it conscientiously, is to pass a very large volume of air at the early stages of drying. Therefore it would be prolonged somewhat longer than you think; I think so. But it would be at that stage that the bulk of contamination would take place. I do not ignore the suggestion you make as to the physical conditions favouring that absorption. I think they do; but this is certain, that I have found that if you want to test for arsenic in a malt-house, the proper place to go to is the malt culms or the dust. That is where you will get the first indication and the best indication.

10013. Have you seen the evidence which was given very lately by Mr. Arthur Angel with regard to the arsenic in growing plants taken up from the soil?—I have read it.

10014. You have noticed perhaps that in his evidence he states that he found no evidence of arsenic being taken up into the seeds of corn, either of wheat or oats or barley?—I have a recollection of reading that.

10015. Traces were found in various plants, in the leaves and growing stems?—He found them in roots too, did he not?

Arsenic in roots.

10016. No, I am going on to that. Among the roots he had only examined mangolds and carrots, and in neither of them was any arsenic found, although they were growing upon an artificially arsenicated soil. I just wanted to ask you another question with regard to that. Mr. Blundell sent you these turnips; were they turnips that the sheep which died was supposed to have been fed on?—I could not tell you as to that. I only mentioned this case because I thought it due to him to do so. He sent me these samples, and I tested them and I did find the minute quantities of arsenic I have mentioned. But I do not think I am in a position to give any exact data as to the conditions. With regard to barleys, I should like to point out that the barleys reported in the Committee's report were divided between Dr. Stevenson, Dr. Luff, and myself. We found certain of them to be free, in the numbers I have said, and certain of them to contain these very distinct traces. They are only minute, but they are distinct. To that extent I cannot agree with the evidence of Mr. Angel.

10017. I do not suppose that your experiments were conducted in the same way; you do not know whether they were found in the husk or in the actual seed?—I could not tell you that.

Advantage of brushing malt.

10018. You have not told us anything about your views in regard to brushing the malt?—I think brushing is most beneficial. The more the desirability of the use of a Boby machine, or some similar machine, can be impressed upon the brewer and the maltster the better. Both the maltster and the brewer should brush the malt as much as possible; I think there is no question as to that. Of course, they want to take care in doing that to brush it prudently, and not to break the malt. A good deal of it is broken. It ought to be done carefully. As to the desirability of doing it, there can be no question whatever.

10019. Do you think it is right for the brewer to use any unbrushed malt?—Substantially I do not think he does. It is bound to be brushed in a measure. The question is, to what extent.

10020. We have had it in evidence that while some maltsters never send out unbrushed malt, others do, and the brewer may or may not subsequently give it a brushing at the brewery?—That would not be within my experience. If that is so, I think it would be very desirable that it should be brushed by the maltster.

10021. The malt should be brushed by the maltster?—I think so.

10022. Would you suggest that it should be brushed by the brewer as well?—It would be advisable as an additional precaution, but I do not think it is absolutely necessary if it is well brushed at the malting. One must not put too much work upon the brewer: he has to conduct his operations within a given time. He has to start early in the morning, and finish his work at 5 or 6 o'clock. You must not make the operation too lengthy, or else it will not be a practicable process. If you interpolate some extra hours' work into his day's run, he cannot get through.

10023. Does not that apply equally to the maltster?—No, he has comparatively nothing to do for a large portion of the year. He has his stocks of material, and he can always brush them up again if he wants; but it does strongly apply to the brewer.

10024. In your opinion it matters but little at what time the brushing takes place: it is not necessary that the brushing of the malt should take place soon after the drying process; it may take place at any time before the maltster delivers his malt?—Yes, I think so. There is no evidence that I know of to make one think it is necessary to brush it immediately. I should think if it were brushed later it would be equally good, so far as I know.

10025. (*Professor Thorpe.*) What steps have been taken to make public in the brewing industry your final report?—We were instructed by the Manchester Brewers' Central Association, and when our report was finished it was communicated to them. I believe they have sent it to every member of their Association, and I think it also appeared in the "Brewers' Journal," but I do not think that any other steps have been taken. Then, of course, notices were sent round. I will take, for instance, one of the very large breweries in London that I act for. They took this report, and they carried out every recommendation except one, which they found impracticable, namely, the recommendation as to hops. They could not carry that out, but subject to that they carried out all of it. As to how far the report has been spread I really could not tell you. Of course we simply reported to those who instructed us, and they issued it to the members of their Association.

10026. In that second report you use a test which is rather more stringent than the provisional or tentative test used when you had to deal with an emergency?—Very much more so.

10027. We have it in evidence, however, that as regards certain samples of brewing materials which were employed in Halifax, the analysts had been directed to make use of the method which you suggested on the first occasion, and that they had been content to rely upon that method?—They should not have been. At the time we gave that first test we did so in ignorance of the existence of traces of arsenic as derived from malt, and when a year ago almost to-day, we issued this report we had then discovered the existence of these traces. We were sure that they were there, and we thought it was the duty of the brewer to exact a more stringent test.

10028. Although you say the analyst should not have prosecuted that test, I think he rather did it through inadvertence: he probably had not the knowledge of your other report before him?—You are quite right, I ought to have put it in that way, I think.

10029. Now let me come back to my original question—that it would be certainly desirable for you to take steps to make it more fully known that you no longer rely upon what I may call the emergency test as a sufficient and stringent safeguard?—I do not know what steps one could take, except by writing a letter to the "Brewers' Journal."

10030. The final report is a document addressed to your clients?—Quite so.

10031. And it is their property?—Yes, but they have no objection to its being freely used: I have no doubt about that.

10032. Could not steps be taken so that it could be freely used in the sense I indicate, so that brewers may not labour under any misapprehension?—I think it could probably be done by writing a letter to the "Brewers' Journal." I should be pleased to do that.

10033. I think it would be advisable that you should at once take steps to let the analysts know, and everybody concerned know, that you no longer rely upon what I call the first method as a sufficiently stringent safeguard?—Yes, I will do so.

10034. (*Mr. Cosmo Bonsor.*) I should think the different brewing societies could circulate it, after what Dr. Thorpe has said?—If you suggested it to them I think they would do so.

10035. (*Chairman.*) You see the importance of the point, do you not?—Yes.

10036. (*Professor Thorpe.*) I gather from what you said that you yourself have a slight personal predilection in favour of the Reinsch test?—No, not as a refined test, but as a test that could be used where the other is not practicable. I have no predilection. I think each one has its own particular application. I have said that as regards the official test, I should keep to the Marsh-Berzelius test, but I should not put that into the hands of a lad to make any tests in the brewery. These tests, if the Reinsch test can be applied, are so easy that just as in chemical works they give a man testing to do, so they can give him these Reinsch testings to make, and if he gets anything suspicious he can bring it to the notice of his superior. There is no difficulty in that, whereas if you ask the brewer to apply the Marsh-Berzelius test in such a form he could not do it.

Advocates Reinsch test for unskilled use.

10037. I want to know why he could not do it, assuming that an official form of apparatus was devised which was purchasable from recognised dealers in chemical apparatus, and that these tubes were prepared, the whole method of procedure carefully laid down, and printed forms issued. Where is the difficulty in its application by an intelligent youth?—He has first of all to be sure that he has pure materials, and that is part and parcel of the whole thing.

10038. But he tests that to begin with?—I know: that is what I am coming to. He has to do that before he can apply the test at all. But all that is a question of time, and there is a difficulty in getting these materials quite pure. You might tire the man before he has come to work it in a going concern, whereas with the other it appears to me to be so simple.

10039. He would have to do that in connection with the Reinsch test?—But they are much fewer. You have only hydrochloric acid there. You have four or five substances in the other. Acid, zinc, calcium chloride, and lead acetate paper have to be used, and it becomes a complicated process to my mind. I do not know whether these test tubes would always be supplied of the proper calibre: if not, he would have to make them himself.

10040. My suggestion is, that a sufficient supply of these little tubes should be furnished by the dealer with the apparatus?—It appears to me to be a case in which you could educate boys or lads to make the Marsh-Berzelius test—I do not doubt it for a moment: but the Reinsch test is one which will adequately guard against any danger, and it can be applied in a brewing room or anywhere else without any trouble whatever. That is why I fancy it, not only because it is more practical, but it is useful for rough purposes.

10041. But my difficulty is—and I am sure the Commission will appreciate it—that you have two competing tests which are not strictly comparable one with the other in operation?—I do not call them competing in this sense. We recommend in our report that if we get a coloured copper by the Reinsch that should earmark the material operated upon, and it should then be tested as a final test by the Marsh-Berzelius test.

10042. By whom?—That is a matter for arrangement. If the lad who makes the Reinsch test is able to make the Marsh-Berzelius, well and good; but at any rate, it is pointed out to him as he runs through these things very quickly that there is a sample which is suspicious, and has to be re-tested. It is a matter of arrangement, a question of organisation.

10043. Just think what would happen in a works. A man makes this test, and finds that his materials are suspicious. He has no method of knowing what the

Mr. A. G. Salamon.

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danger amounts to, but he has to stop. Whereas if he went on to use what I hope will eventually be prescribed, this Marsh-Berzelius test, prescribed with the details that you suggest, he would at once know where he was?—I have seen as many as 400 or 500 of these Reinsch tests going on in one laboratory at a time in Manchester. I do not think you would be likely to see as many Marsh-Berzelius tests as that going on in a room.

10044. Those were beers, were they not?—Yes; I am speaking of a lad employed at a brewery, where you run 20 or 30 of these Reinsch tests at a time. It is impossible to do it with a Marsh-Berzelius. Supposing a brewer wants to control his stock; he says, "I will employ a young chemist at £50 or £100 a year to test my material." He can do it like that with the Reinsch, and except in cases of danger he will pass everything fairly and quickly, whereas if he employs the Marsh-Berzelius test it is not practicable for every-day work. I quite admit it is the best test; I am not confuting that for a moment.

10045. I do not think he would have such an enormous quantity of malt to look over; he would have a certain number of samples to test; he would have a certain amount of invert or glucose coming in; he would not have a large range of materials, and he would not have a great multiplicity of tests to conduct?—There are a great many. As you know, the brewers do not use one class of malt, as a rule; then there are all the raw materials and the preservatives.

10046. A lad could easily do a dozen Marsh-Berzelius tests in a day?—It would be more than he could do, I think.

10047. I am speaking from experience, and our official hours are not so long as those that are worked outside?—Then we cannot get the assistants to work as rapidly as they do at the Government Laboratory. I do not think I could get men to make as many tests as that; whereas I am sure I could get 40 or 50 by the Reinsch.

Modification of kilns.

10048. You have told us that you have considerable professional dealings with maltsters?—Yes, that is, as an analytical chemist.

10049. Is it not the fact that one difficulty there would be in carrying out any re-arrangement as to structural alterations arises from the fact that in many cases—I believe in the majority of cases—the premises are not the property of the maltster; he is a mere tenant?—I could not speak as to that.

Anthracite preferred to oven coke.

10050. You told the Commission that you think anthracite is distinctly preferable to any form of coke?—I think so.

10051. Even to oven coke?—As regards certainty, yes.

10052. Why do you give preference as regards oven coke?—Because, as I understand it, the coal for making oven coke is particularly selected on account of its freedom from pyrites because they do not wish the coke to contain sulphur. That is merely a question of selection, whereas the anthracite is naturally freer from sulphur than the coal from which the coke is usually made; therefore there is a chance even of oven coke becoming contaminated.

10053. Unless the same process of selection were gone over in the case of anthracite, namely, hand picking, you would be liable to a recurrence of this state of things?—You would. But you must bear in mind that, as far as I know, they would never malt with coke alone. They use a mixture of coke and coal, and they use it at different stages of the kilning. Supposing you were to employ a washed oven coke, you could not malt with that only; I never knew of a maltster who did.

10054. Is it not a fact that the distribution of pyrites in coal is so fortuitous that it is no necessary security to say that a certain colliery is reasonably free? It might be free for a week, and then the next week you might come upon a seam where a considerable quantity of pyrites might be present?—That is so: but of course we must take the average of these statements, and it is perfectly practicable, as I find and as I understand the position, to get anthracite which is substantially free from pyrites, if care be taken in the selection.

10055. In looking it over?—Yes, it is advisable that it should be looked over; I quite agree with that.

Effect of iron in soil on arsenic in plants.

10056. With reference to the question that was put to you about experiments on the soils and the assimilation of arsenic by plants, would it not make a great deal of difference to the results if, for example, the soil contained any sensible quantity of ferruginous material, say hydrated oxide of iron or carbonate of iron—would not that make a great deal of difference as to where the arsenic went?—I should think it would.

10057. In other words, you might add arsenic to a soil containing ferruginous material and practically it would be all locked up by the iron?—I think that is a very proper and just objection; I quite think that that might happen.

10058. You have no proof that arsenic could not under certain circumstances be assimilated by a plant growing in a soil, because in certain soils such plants have been found to be free from arsenic?—I think that is also a very just objection. It is a question which ought, in my opinion, to be taken in hand by such a body as the Royal Agricultural Society. These questions certainly arise in connection with the statement that has been made as to non-assimilability and non-absorption. I think there are many other kindred questions that would arise in connection with this problem.

Anthracite should be guaranteed as picked a selected.

10059. (*Dr. Whitelegge.*) With reference to the anthracite, you told us that the brewer could not analyse it. What precautions do you think it would be proper for a brewer to take in getting his anthracite: what steps ought he to take to insure that the anthracite he gets is free from arsenic? Should he require a certificate?—It might be well for him to get it.

10060. A certificate of what?—I would rather ask for a certificate of general purity in terms of an assurance that it has been particularly well hand picked and selected than that he should ask for a guarantee as to its freedom from arsenic. It is so difficult to guarantee a cargo of coal. The question of sampling comes in. It is so extremely difficult to sample the bulk.

Guarantee freedom fr arsenic of value.

10061. The proper course would be, not an assurance that it had been analysed, but that it had been washed and picked?—Yes, washed, picked, and carefully selected; I would ask for that assurance. I should not attach any value to his guaranteeing it as free from arsenic, because he would not be able to check it; it would be upon his guarantee.

10062. You would also take into account some selection in the seam of the colliery?—Yes.

10063. (*Sir William Church.*) Would it be possible to do that; is not anthracite delivered in large blocks which are broken up by the maltsters themselves?—I do not think the maltster could undertake to pick and select the anthracite. As I understand it from the maltsters, when picked and selected anthracite is delivered to them it is picked by those who supply it. It may be that the large blocks are picked, and perhaps that gives them quite sufficient indication, but I do not think you will get the maltster to break up the anthracite small and then pick it over, and so on. It would be out of the question, at least as far as my experience goes.

10064. (*Dr. Whitelegge.*) The difficulty is in obtaining a sufficient and adequate sample of the class of coal?—Yes, a true sample.

Sampling malt.

10065. Does not that difficulty apply to some extent to malt? What precautions do you ask for in sampling malt?—I do not think the same difficulty applies, because it is generally taken from the bins, where you have large storage accommodation, and it represents a bulk supply. They dip well into the bin.

10066. We have been told of accidents happening from accumulations of arsenical dust falling down from the rafters, and so on; you would not think that a material consideration in sampling malt in general?—No, I would not.

10067. You gave us the results of a number of analyses of malt pointing to a more satisfactory condition in recent months; were those samples sent to you for analysis by your clients?—Yes.

10068. Do they represent in any large number the smaller brewers?—Yes, both large and small.

10069. You told us that you anticipate difficulty rather in the case of the small brewers than in the large ones in the matter of precautions?—As to their liability to use impure materials I should.

10070. Would you suggest that the public should be protected in the case of the small brewers if your recommendations were carried out?—In the same way as the large—that the Government Laboratory should analyse and report upon samples so as to control and warn him if necessary.

10071. But those would be infrequent samples, would they not?—Yes, but it would be quite enough for him to know that he was under control.

10072. They would be samples of finished beer or wort, and have no regard to materials?—If they found that the wort or finished beer contained an undue amount of arsenic they would at once be thrown back upon a searching investigation of the raw materials, and they would warn the public authorities, as I suggest, that they should devote their attention to this particular brewery, as there was danger of the public health not being safeguarded.

10073. Do you mean the local authorities?—Yes.

10074. You do not mean the Inland Revenue?—No, the local authorities; that the Laboratory should communicate with the local health authorities of the district where that brewery was, and notify the brewers in question what had been done.

10075. In order that the local authority may take action under the Sale of Food and Drugs Act?—Yes.

10076. Presupposing a standard made statutory in some way?—Yes, and that the brewer was found by the local authority, after having been warned by the Government Laboratory, to exceed that standard.

10077. Then you would pay no attention to the amount of arsenic that might be present in one or more of the brewing materials?—Eventually one would have to trace it down and find the reason. Perhaps he would stop the beer going out, which is what you want to do.

10078. But it might have been consumed?—It would be quite impracticable to test all the beer that is brewed. Therefore you must make it a question of periodic testings.

10079. Do you think that the reference to the local authorities would be a sufficiently speedy manner of dealing with it; you know probably better than I do that the procedure under the Sale of Food and Drugs Act is not quite the most rapid?—I am afraid I could only suggest that someone ought to take the matter in hand, and act as speedily as possible in such a case.

10080. I quite understand that you limit your suggestion to the beer and the wort. Would it not be a further protection if in the same way the materials could be safeguarded?—Undoubtedly, and I have suggested that in order to safeguard those materials you should make it penal to employ any arsenicated acid in the production of the materials used as raw materials.

10081. That would not be the brewery?—No; and that you also make it penal to use gas coke in the preparation of the malt. Then, having those two safeguards, I think the other would be a sufficient one. If you have too many safeguards you will not get them observed. You must make them as simple as you can in dealing with a great industry like this.

10082. Would you not advocate a standard test for raw materials, as regards malt?—As regards malt, I think the Commission might very well pass a certain standard beyond which it should be considered contaminated. But as regards the other materials, I think they ought not to be allowed to contain it at all. It can easily be kept out, and at a very small added expense, and I believe the brewers are perfectly willing to do it.

10083. As regards the prohibition of sulphuric acid containing arsenic, the Board of Inland Revenue could not administer that?—No, they could not do that.

10084. Would you suggest that the local authorities should do it?—I am not quite competent to make suggestions in that direction. I have only given the idea for what it may be worth. I have examined many food products, and I have been surprised at the number in which you do find traces of arsenic, and in medicinal products as well. I think that ought not to be permitted, seeing it could be avoided at a very small cost.

10085. You mentioned certain things that the brewer ought to do: how would you propose to bring home the responsibility in any way to the brewer? I am assuming that you accept the recommendations of the Committee of which you are a member. Have you thought of any way in which those recommendations can be brought home to the brewers in general? You do not think of them, I suppose, as statutory obligations, but you think they should require certificates?—No, it is only a moral obligation on the brewer, knowing there is a danger, to do his best, and I am sure he has done it. I am quite sure that since the brewer knew the danger of contamination by the malt he has adopted either these suggestions or similar ones, with the result that we know to-day.

10086. I do not think you mentioned in the evidence you have given this morning anything connected with the importation of substances intended for use in breweries?—It follows that if the Commission recommend legislation controlling the purity of sulphuric acid and prohibiting the use of gas coke, for instance, imported articles, such as foreign glucose, caramel, and so forth, should be equally pure, as would be produced by the use of materials such as are suggested in this country. Otherwise it would be very unfair to the home producer. I may say that it is no cheaper, as far as my information goes, for a foreign manufacturer of sulphuric acid to purify from arsenic than it would be for an English manufacturer, so that the English manufacturer would not be prejudiced.

10087. Would there be any difficulty in showing that it was intended for the manufacture of food?—I do not think so, because it carries its own definition. Glucose, we know, is intended for food. It would merely be as to what was the interpretation of the term.

Briquettes.

10088. (*Professor Thorpe.*) Has the attempt been made to use anthracite dust in the form of briquettes in malting?—I have seen it done, but I am not sure whether it was anthracite dust or a mixture of anthracite and other dusts; but I know that the use of briquettes is extending somewhat in maltings. It is curious that you should ask me, because I was consulted about it not very long ago.

10089. Are the results favourable? Is there any difficulty in the use of briquettes in maltings?—I would not like to give an opinion yet, because I do not know sufficient about it; the matter has only recently been brought to my notice.

10090. You observe the point of my question, that if the coal were reduced to dust, a fine powder, there would be very much less chance of any considerable quantity of pyrites being mixed with it; it would undergo a preliminary sifting?—Quite so.

10091. And the earthy material which is part of the briquette would also tend to retain, or it might be so arranged to retain, even such quantities of arsenic which escaped the sifting process?—I would not like to give an opinion as to the results that have been obtained at present in that connection. I can only say that I know it has been tried, and as far as I can see and say, the results have been satisfactory.

TWENTY-FOURTH DAY.

Friday, 13*th June*, 1902.

AT WESTMINSTER PALACE HOTEL.

PRESENT:

The Right Hon. Lord KELVIN (*Chairman*).

The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Professor THORPE
Dr. WHITELEGGE.

Dr. BUCHANAN, *Secretary*.

Mr. OTTO HEHNER, re-called; and Examined.

Mr. O. Hehner. 13 June 1902.

10092. (*Chairman.*) I believe you appear here by request of the Royal Commission as the delegate of the Council of the Society of Chemical Industry, and, together with Mr. Alfred Chapman, as one of the delegates of the Council of the Society of Public Analysts?—That is so.

10093. You gave evidence before the Commission about a year ago?—Yes, some time ago.

Report of Arsenic Committee of Societies of Pub. Anal. and Chem. Ind.

10094. Since that time you have been working at the subject in order to be in a position to recommend the best process for the detection and approximate estimation of minute quantities of arsenic?—The Society of Chemical Industry jointly with the Society of Public Analysts appointed a committee for that object, and I was one of that committee, and the chairman of it. When I was here last this committee had been appointed, but no report had been made. Since then a unanimous report has been issued. The Council of the Society of Chemical Industry was asked whether they would ascertain the opinion of those of their members who had tried the process recommended by the committee, but the Council of the Society of Chemical Industry did not see its way to arrange a discussion of the report by the members, as that society has seven separate sections in England, and two in America and Canada. The Society of Public Analysts, however, held a meeting, to which I, as chairman of the London section of the Society of Chemical Industry, invited the members of that society. The Public Analysts' Society sent out circular letters, with certain questions, to their members. Answers have been received, which my colleague, Mr. Alfred Chapman, will put in evidence before the Commission. They also held a meeting to discuss the committee's report.

Meeting and discussion thereon.

Marsh-Berzelius test recommended.

10095. I understand that the Joint Arsenic Committee unanimously recommended the Marsh-Berzelius process?—They laid down, as minutely as can be done in an analytical process, the conditions under which the best results, in their opinion, are obtained, and they gave some additional information to their members of how, in their opinion, the materials necessary for the test could be best obtained in a state of freedom from arsenic. They found that when pure material (acids and zinc) had once been obtained, this method is the simplest, most rapid, and most certain method in detecting minute traces of arsenic and estimating the amount with very considerable accuracy.

Satisfactory zinc.

10096. One great difficulty is to obtain a zinc free from arsenic?—It is a very great difficulty to obtain pure acid and pure zinc, and to maintain them pure.

10097. Is it not an easier matter to obtain pure acid than to obtain pure zinc?—Yes. The zinc can be obtained by electrolytic processes, but such zinc is so pure that it is not well applicable to the test. It will not evolve hydrogen with the acids when it is in a state of great purity. At the same time, we have made experiments with the view to deprive commercial zinc of its arsenic, with some considerable measure of success.

10098. Would not one great difficulty be obviated by doing away with the zinc altogether?—Yes, if it would work, undoubtedly it is the theoretically ideal method.

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Question of electrolyti method of applying t test.

10099. The electrolytic process simply involves putting the electrolytic generator into the cell in which the substance to be tested is placed. If you take the electrolytic generator to another cell you do away with one great difficulty?—Undoubtedly, but the plain electrolytic method, without a metal which goes into solution like zinc, simply taking platinum electrodes, does not seem to have been attended with any success in the hands of those who have tried it.

10100. If they try again, I think they should succeed. It should be, and in point of fact it is, essentially easier and simpler than the Marsh-Berzelius process?—It may be, but we, as analysts, have to deal not with an ideal process. If the conditions were once really well worked out, so that all the arsenic should be given off in a state of arseniuretted hydrogen, and none deposited or transformed into other substances, it obviously would be the best method.

10101. You have told us that pure zinc constitutes in itself a difficulty because the bubbles will not rise from it. If you laid a piece of platinum upon the zinc, that difficulty would cease, and you could use pure zinc?—No.

10102. You do not get the bubbles to rise from the zinc; but you do from a piece of platinum touching the zinc?—With the very greatest respect, I may say that experiments we have made show that if platinum, for instance, is put on the zinc, the evolution of arsenic is very very far from quantitative. You will presently have, from my friend, Mr. Chapman, some results which have been obtained in that direction. We have found that whenever a metal is added to pure zinc, arsenic free zinc, it retains some of the arsenic.

10103. It would be easy to arrange a pure electrolytic process with wires leading into the cell?—We should be delighted if we could get the information from you as to the exact conditions under which this can be done.

10104. I think the arrangement ought not to present any difficulty. Chemists have not generally followed—perhaps they have no time to follow so great a science besides their own—electrolytic methods; but I think if you try you will find the difficulties may be altogether imaginary?—Chemists are not good enough electricians as a rule to work a process of that kind.

10105. That is a fault easily mended, if it is a fault. There seems no doubt whatever that you have found the Marsh-Berzelius process to be the best?—From a chemical point of view. We have a great difficulty in getting pure materials; but the pure materials having been once obtained and zinc having been proved to be sensitive—we have frequently met with zinc which is far from sensitive, from electric reasons no doubt—the most minute traces of arsenic can be detected and approximately determined in quantity.

Zinc.

10106. It seems desirable that zinc should not be put into the cell at all which contains the substance to be examined; that is to say, that the electro-motive part of the apparatus should be in a separate cell?—If your Lordship could give us an idea of how to prevent the separation of arsenic in the elementary state, instead of its being evolved in the form of arseniuretted hydrogen, it would be valuable to us.

10107. There is a distinction, of course. The public analyst of Nottingham has sent to the Commission an account, which is in Dr. Thorpe's hands, of a process which he claims to be successful, in which he has taken advantage of the electro-motive force in the electric light wires; but that is not at all necessary. It should not be possible to fail in carrying out an electrolytic process tried in the simplest possible way?—If your Lordship could tell me how small a quantity of arsenic was discovered I should be obliged. We can all evolve arsine and detect it in that way; but we find that we can detect smaller quantities by the actual chemical method than by the strictly electrolytic method.

10108. The smallest quantity that can be detected by the electrolytic process, I would say, is as small as could be detected by any other process whatever. There is no doubt that, even with the zinc, you can by great precautions get good results by the Marsh-Berzelius test?—We can get excellent results.

10109. You had a meeting of the Society of Public Analysts?—Yes. We held a meeting in order to give the members an opportunity of either adding to our knowledge or criticising the process as laid down, and a great many suggestions were there made as to *minutiæ* of working the process and the purification of materials, but with one eminent exception all the members were agreed that of chemical methods the Marsh-Berzelius was the proper method for this purpose. That exception I lay some stress upon, because it was Dr. Stevenson, who was of opinion that the Reinsch process was good enough for the purpose.

10110. While you were unanimous, with one exception, that the Marsh process is preferable to the Reinsch, one member maintained that the Reinsch had certain advantages?—Yes.

10111. Did he maintain it was the best in all cases, or only in some cases?—He said it was the best process for commercial purposes, but he said that at the same time its limit for beer was 1-50th of a grain per gallon, and that it could not go beyond that. We, however, generally think that 1-50th of a grain and a smaller quantity ought to be easily discoverable.

10112. By the Marsh-Berzelius test it is easily discoverable?—Quite easily.

10113. At this meeting of public analysts it was felt that the Reinsch test was not sufficiently sensitive for practical purposes, and that deposits formed on the copper in many arsenic-free beers might give rise to mistakes in the hands of more or less unskilled operators?—Yes; in many cases a deposit is obtained when there is no arsenic at all, and that has to be identified as arsenic, which is not an easy matter.

10114. On the other hand, you find that the Marsh-Berzelius method can be readily worked, given pure materials, by comparatively unskilled persons?—Yes; the difficulty is to get pure materials. When once obtained, a small amount of experience and skill will enable a man to work it. There is the additional advantage that the arsenic deposit in the tube, however minute, can be very readily identified as arsenic.

10115. Were any slight modifications suggested at the meeting?—Yes; small modifications were suggested.

10116. What did those modifications deal with?—In the first instance, with the purification of the acids required for the testing. We had recommended a method of depending on the volatilisation of arsenic from the acid, and then distilling the remainder, first getting rid of the arsenic from the acid, and then distil the remainder, and thus get it arsenic-free. A good many of our members were of opinion that it was simpler to oxidise the arsenic to the arsenic condition, and then distil, when, in their opinion, arsenic would not distil off, and pure acid would thus be obtained. Experiments show, however, it is quite impossible to boil a solution containing arsenic acid without getting some reduction at the same time.

10117. Were there other modifications, such as cooling the glass tubes?—Yes, with a little piece of blotting-paper and things of that kind; but it has really nothing to do with the method itself.

10118. Did any of these proposed modifications touch the essential principle?—There were small analytical modifications.

10119. And the process as laid down by the committee you consider practical and easily followed?—The process as laid down by the committee, given pure materials, is very easily followed, and gives sufficiently accurate results with a minimum of trouble. We have in the meantime found out that we can purify the acid somewhat more effectually and certainly by a slight modification of the process here laid down. I have also found, in the meantime, that zinc containing arsenic can be readily freed from the arsenic so that it becomes pure. Satisfactory zinc.

10120. It seems to you that it is preferable to choose a method that is capable of showing exceedingly minute traces of arsenic, traces much smaller than are likely to do harm to human beings; it is much better to adopt such a method than to adopt a blunt method?—Yes. Of course it may be of no practical importance to discover the most minute things, because it is not well to create unnecessary alarm. It has been often suggested that a comparatively blunt method like the Reinsch method should be taken, and whatever articles of food do not show arsenic with the Reinsch should be considered to be good enough. Against that I wish to urge this: Supposing the Royal Commission made some limit of some kind, as I suppose will be done, and that later it was found that this limit was unduly severe, then the limit of quantity allowed could be easily altered; or it might be found that more minute traces of arsenic do harm. If we have a blunt method, in ten years' time we shall have no experience whatever of small traces. All our experiments will be wiped out. It is better, I think, to know exactly what there is. I want to get exact results, from which in future times we may be able to draw some really good conclusions. Objections to "blunt method."

10121. The intelligent operator ought to have the responsibility of passing or rejecting samples, knowing exactly how much arsenic is present?—I think so. It should not be the method that rejects it; it should be the operator.

10122. You do not think it would be good policy to throw the onus on a comparatively indiscriminate method?—I think it would be better to have a good and delicate method.

10123. Have you seen any reason to change your view that in beer 1-100th of a grain of arsenic as arsenious oxide might be the limit?—Of course, I am not a physiologist, and I can only judge from my chemical experience. I find that very many beers contain now less than 1-100th of a grain per gallon, and that a brewer can with reasonable care manage to get beer with less than 1-100th of a grain per gallon. It might be difficult to work to a much smaller quantity. The malt as now made contains none or so little arsenic that the beer can be readily made with 1-100th of a grain per gallon, or less. Beer easily made with less than 1-100th grain per gallon.

10124. You think that absolute freedom cannot with certainty be obtained?—I think not; it could be often obtained, but not quite certainly. Absolute freedom not quite certainly obtainable.

10125. You would recommend the Marsh-Berzelius process alone; you would not advise alternative processes, the Reinsch process for some cases?—Not for beer and malt, because the quantities we have to deal with there are less than those which the Reinsch process can discover. But in other materials, not to be used in quantities like beer, the Reinsch process might possible do, because obviously all substances cannot be judged by the same limit.

10126. Confining our attention for the moment to beer and malt, you would dismiss the Reinsch test?—Yes, I would dismiss the Reinsch process absolutely. Objections to Reinsch test for beer and malt

10127. But for other materials, other cases of testing, might the Reinsch process have advantages?—I do not know whether it would have advantages. I do not see any advantage in the Reinsch process. Once having pure materials for operation, I can identify a deposit which one believes to be arsenic more certainly by the Marsh process than the Reinsch.

10128. So that while the Reinsch process might in some cases give good results, you would still prefer the

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Marsh process?—I would. There are a good many chemical details which may be worth discussing, and many of these will be referred to by my friend, Mr. Chapman.

10129. Would you now wish to add or alter the method of your committee in any points of detail?—Not the method. I divide this report really into two portions; the one deals with the analytical method, and there I have nothing to add or alter in any way; the second part deals with the preparation of reagents required, and of course that was not really the essence of the method, but was only to make the work easy to our members. Formerly, and, in fact, even now, some members preferred to go about to every chemical dealer, and find acid which is pure or find zinc which is pure, and then lay in a stock, and in that case the preparation of materials does not come into consideration. But we went out of our way to some extent to inform the members of the two societies how, in our opinion, they might obtain pure acid. I have since added a little paper, published in the journal of the Society of Chemical Industry, on the preparation of pure zinc. We have found that sometimes hydrochloric acid cannot be purified by the process laid down here, which depends upon dilution of the hydrochloric acid, the addition of bromine, and the addition of sulphurous acid; that is to say, the addition of hydrobromic acid. Generally, an acid thus treated gives a pure arsenic-free product, but sometimes it refuses to do so, for reasons that we do not understand. But we have found that if the acid is not diluted, if fuming acid is taken and treated with hydrobromic acid, and the first deposits rejected, we have no difficulty in obtaining a perfectly arsenic-free distillate from crude yellow highly arsenical acid. As to the zinc, I would like to add that if arsenical zinc—and some commercial zinc is highly arsenical—is fused, and pieces of sodium are added, and the sodium allowed to oxidise, it takes out the arsenic with it, as magnesia helps to remove the arsenic from iron. It takes out the arsenic in a form I do not know—the quantities are too small to test. If such zinc is poured into any crucible and treated once more to remove the last traces and then granulated, it is found to be perfectly free from arsenic. But great care has to be taken to remove the sodium as completely as possible by oxidisation, or otherwise the zinc becomes insensitive, that is to say, it does not show arsenic in minute traces when the arsenic is added to it. Mr. Chapman will tell you that we found the addition of almost any metal lying far away in the electric scale from zinc prevents us getting a delicate result. That is all I have to add to the details given in this report.

Pure acid.

Satisfactory zinc.

Delicacy of Arsenic Committee's test.

10130. The committee's method is delicate, to 1-100th of a grain per gallon. Can you say how much less than 1-100th of a grain?—In operating on 20cc. of beer, without destruction of organic matter, one can discover ·003 of a grain per gallon, which is 1-300th of a grain per gallon. But if one destroys the organic substances and operates in that case upon a larger quantity, which is quite easy, one can discover a much smaller quantity, according to the quantity operated upon. Without the destruction of organic matter it is not so easy to work upon more than 20 or 30 cc.'s, and then the limit of sensitiveness is about 1-300th of a grain per gallon.

10131. The mere evaporation of two or three volumes of beer down to one volume or less would not destroy the organic matter?—No. The organic matter must be destroyed by agents like nitric or sulphuric acids. All the oxidised matter must be removed and the mineral solution tested.

Destruction of organic matter

10132. What would the effect of destroying the organic matter be:—That one can concentrate a large quantity into a very small bulk, and thus get results of any delicacy one chooses. Beer itself, either in its unconcentrated or concentrated condition froths so much with the evolution of hydrogen in the apparatus that it is difficult in a small apparatus to keep the frothing within bounds. If one takes a larger apparatus it naturally becomes a less sensitive operation. It is a mechanical difficulty.

10133. Does beer always froth in the Marsh-Berzelius test?—Not always. Some of the heavy and very black beers are apt to froth, and the beer has to be introduced quite slowly, so that the froth does not fill the flask. The bulk of beers do not froth.

10134. That really is an objection against concentrating the beer by evaporation?—Yes.

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10135. For practical purposes it would be too long a process, but for scientific purposes, and for discovering the minutest trace, beer might be evaporated down to 1-10th of its volume?—Yes, but it would be better to destroy the organic matter, as we have recommended as an alternative in the report, by adding nitric and sulphuric acids and charring all the organic matter, or oxidising the organic matter entirely

10136. None of the arsenic would be really lost?—None; we have made careful experiments.

10137. Are we to understand that your committee recommends in certain cases the destruction of the organic matter?—Yes. Where we can avoid destruction, for the purpose of simplicity we work without destruction. When any mechanical difficulty presents itself, like frothing, or in connection with yeasts which froth greatly, and destruction is necessary, we have given an alternative process of destruction, and that alternative process allows of the use of as large a quantity of the material as the operator chooses to take.

recommendended in certain cases

10138. You may go, in that case, to a greater sensibility than 1-300th of a grain per gallon?—To a far greater degree of sensitiveness.

and allowing greater sensitiveness.

10139. Does the mirror report all the arsenic?—I am afraid I cannot answer the question. I know of no method sensitive enough to discover any residual arsenic, but as the mirrors obtained from different minute amounts of arsenic appear proportional in density, there is no reason to think there is any residual arsenic in the flask under proper conditions. In some cases there is, because with so-called insensitive zinc there must be a residuum.

10140. What volume of liquid is used in the Marsh apparatus?—20cc. is, as a rule, sufficient, and 10 is sometimes sufficient. With highly arsenicated beers I have obtained strong mirrors with 1cc. of beer.

Volume of liquid in apparatus.

10141. In the same apparatus can you use a larger or smaller quantity?—Yes.

Effect of dilution on mirror.

10142. Do you get the same mirror from the same quantity of arsenic whether you use 10cc. or 20cc. or 50cc. of liquid?—Within those limits, yes. If I add to the apparatus in which only the zinc and acid is present, a standard solution of arsenic, introducing, we will say, 1-1000th or 1-2000th of a milligramme, I get a mirror which is identical in depth, whether I dilute the standard solution with 10cc. of beer or 20 or 40cc. I do not think, if I used a much larger quantity of dilution, this would be the case, or, at least, a longer time would be required to obtain the same mirror, as obviously there would be less chance of the molecule of arsenic coming into contact with the zinc.

10143. The mirror would be formed more rapidly in one case than in the other?—Yes.

10144. But the ultimate appearance is the same for the same quantity of arsenic?—Yes.

10145. In the case of malt, is all the arsenic removed by digestion at 50 degrees centigrade with hydrochloric acid, as recommended?—I can only answer that in this way. If malt is charred by nitric and sulphuric acid, or if it is extracted with warm acid, the results have been the same.

10146. Supposing it was required to condemn any beer containing arsenic, say, 1-100th of a grain per gallon, would you say that it would be safe for administrative purposes to fix 1-100th of a grain, or should the administrative limit be lower, say, 1-200th of a grain in order that there may be no question about the 1-100th of a grain?—I think that would be rather too great a difference. I do not think if a limit of 1-100th were fixed, anybody should be prosecuted on a quantity so little larger as would lie within the limits of experimental error.

Allowance for error in estimating quantity.

10147. (*Sir William Hart-Dyke.*) With regard to the possibility of fixing an amount of arsenic which is so infinitesimal as to be harmless to the drinker of beer, you are aware, are you not, that evidence here has been given in favour of rejecting the finished article in any case when there is any arsenic, however small a quantity detected?—Then you had better shut up all the breweries in the kingdom, because no brewer could possibly guarantee every batch of beer brewed by him, whatever care he takes, to be arsenic-free.

Objections to guarantees based on "blunt" tests.

10148. That being so, the question of a guarantee is a very difficult one to consider?—Yes.

10149. The guarantee could not be given?—No. Many dealers, maltsters, and so on, have guaranteed their malt to be arsenic-free because blunt tests by their chemists had been applied, which showed it to be free from arsenic; but more delicate tests will often show the presence of arsenic, or by taking a larger quantity for the test it could be discovered. A man would inevitably, under these conditions, get into trouble for giving a guarantee for something he really cannot guarantee.

10150. You think by the constant care in the use of ingredients in brewing, the brewer could give a guarantee as to safety to the public, where he could not give a guarantee as to absolute freedom from arsenic?—Undoubtedly. I do not think a brewer should be always obliged to say to the public that his beer contains arsenic. It would be obviously to his prejudice in the eyes of the ignorant; but that which is below a quantity to be fixed by the Commission should be called quite pure.

10151. In your scheme of analysis you reject altogether what you consider is a blunt method?—Yes.

10152. The blunt method being a method which stops at the discovery of a certain quantity?—Yes.

10153. And is practically useless beyond that?—It would be misleading, and it is misleading the brewer and the maltster.

10154. You rather hold out, do you not, the possibility of allowing considerable discretion to the analyst in the selection of samples? You say that the intelligent operator ought to have the responsibility of passing or rejecting samples, knowing exactly how much arsenic is present. Would you develop that a little, and just say what is running in your mind?—It seems to me that, t[illegible]g the blunt test, is like an ostrich putting its head into the sand; it does not want to see a certain thing, and, therefore, does not see it. I think the analyst ought to know how much there is. If a limit is fixed, say, 1-100th of a grain, and the analyst finds, say, something less, he naturally would pass it. The responsibility ought to be put upon him to say whether a beer complies with the requirements of the Commission. Supposing he finds a trifle more than 1-100th of a grain, within limits of experimental error, I think he ought to have the responsibility of passing that beer. He must know himself how near he can work the method. In any case, we ought to know how much arsenic there is.

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10155. Assuming this Commission did not take the responsibility of laying down what was the precise quantity of arsenic that might prove injurious to health, would you suggest that some department of the State should do it—the Local Government Board, for instance?—Certainly. I think it is most urgently required that a limit should be laid down below which articles like beer should be considered pure. It should not be left to the individual officer, otherwise the traders and brewers will be continually harassed and worried.

10156. And the analyst of the future would work, according to your suggestion, with that fixed quantity before his mind's eye in making his report?—Yes.

10157. Putting samples on one side that are dangerous, and on the other side those which according to the standard are innocuous?—Yes, innocuous according to the law. Obviously you cannot leave that to the individual. Why should I, as public analyst, have the responsibility of condemning a sample on any particular quantity? My brother analysts might think me unreasonably severe or unreasonably lenient, and would appear as witnesses against me, and no case could be carried unless it was one of a gross description

10158. In regard to fixing the precise quantity that would prove innocuous, whether to health or life, of course some dependence must be placed on the amount of beer that is consumed by any one individual. Is it not possible that in the case of a moderate drinker who only drank a moderate amount of beer during the day, an amount demanded by the work he was doing, it might be perfectly innocuous for him to take beer with a certain amount of arsenic in it, while to a regular toper, a man who drank large quantities a day, it might produce disease?—Yes, undoubtedly it would; but I think the toper is just as much entitled to the protection of the State as the moderate man, and whatever limit is laid down, it should take into account, I will not say the most extreme cases, but most cases reasonably likely to occur.

10159. You think your minimum should secure the moderate drinker as well as the other?—It is really a medical question of what ought to be the minimum—a question of evidence as to what quantity has been known to produce ill effects. I am not a medical man, and cannot judge of that.

Absolute freedom of beer from arsenic cannot be secured.

10160. You are still of opinion, are you not, that if we endeavour, by any suggestion we make, to secure absolute freedom from all arsenic in beer, we shall be endeavouring to carry out what is entirely impossible?—You will be doing something absolutely impossible. In our state of civilisation, where coal is burnt—and all coal is arsenical—more or less arsenic must be everywhere. In every particle of coal-dust and ashes that fly about there is a trace of arsenic. How can you say that anything whatever can be absolutely free from arsenic? It is not possible.

10160*. You think, within proper limits, we can get complete security?—I think so.

10161. (*Sir William Church.*) You said that one of the reasons why you thought anything of the nature of a blunt test should be rejected in favour of a more delicate one was the obtaining of results for comparison hereafter. Would you mind just developing that a little?—Supposing for the present the evidence is that beer with 1-100th of a grain per gallon is innocuous; but assuming at the same time it should be some day proved that a beer or a food with a less quantity has produced injurious effects, or might have something to do, as has been suggested, with certain diseases other than arsenical neuritis, then we would have no evidence whatever; whilst if we knew exactly, and had the means of ascertaining, how much beer does contain, and we had statistics at hand, I think we should have an accumulation of valuable material. Supposing that it should be found some day that 1-1000th of a grain has done some harm——

10162. That is what I gathered; but how would you suggest that these statistics should be obtained?—The analyst has his record of all analyses made; every brewer has a chemist, who knows exactly how much arsenic is in the materials.

10163. And those records should be kept by whom?—They are kept by every individual who makes the test, by the brewer, if you like. As a matter of fact, his books are available.

Brewer should record quantity of arsenic found.

10164. If in the future, for instance, a question arose as to the wholesomeness of any particular beer from any particular brewery, you would be able, by consulting these books, to see whether that beer had 1-100th of a grain per gallon or 1-300th of a grain. In other words, you would have the brewer's chemist keep, not only a record of whether he has passed the beer as safe, but you would have a record of the actual quantity he found?—Quite so. I do not suggest for a moment that the brewer should be obliged to do it. Every reasonable and careful brewer does do that now. There should be no enactment about it.

10165. It comes to this—that the analysis should always indicate the amount of arsenic that the analytical chemist found present in any specimen of beer?—Yes.

10166. Not that he merely passes it as having less than 1-100th of a grain?—Quite so.

Unskilled man could be trained to use Marsh-Berzelius test.

10167. (*Professor Thorpe.*) Two or three gentlemen who have appeared before us recently have impressed upon the Commission the desirability of prescribing for the use of the practical man, who need not necessarily have any chemical knowledge, a test which should safeguard him against using impure materials. Assuming the Commission saw the desirability of prescribing such a test, do you think that the Berzelius-Marsh test is a test which could be worked by a person of that order?—He must have some education and some drilling. I would rather that he should use the Marsh-Berzelius than the Reinsch, because he has to actually produce arsenic in a tube, and you can easily verify it; whilst he would require a large amount of judgment in ascertaining whether a certain piece of copper which has a deposit has its colour from arsenic or from other matter. I see no difficulty in

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training a man in a works or brewery or malt-house to test the materials by the Marsh-Berzelius method, given pure materials.

10168. You think it does not demand a knowledge of chemical manipulative processes, and is not so recondite a process that an intelligent youth could not be trained to use it?—I think in a day, or two days, I would train any intelligent youth to do it.

Beer with less than 1-100th grain easily obtainable.

10169. You have had a very considerable experience in the analysis of beers?—Not quite so much of late. Do you mean as to arsenic?

10170. Yes?—I have tested a great many.

10171. I think you told us that in recent time your experience was that beer was gradually getting, I will not say arsenic-free, but that the arsenic was in extremely minute amounts?—Yes.

10172. That is the general average character of the beer, so far as you know, which is being produced?—Yes; beer and malt.

10173. The beer which has come under your hands is beer of that character?—Yes.

10174. You are rather guided, I understand, in your fixing of such a minimum amount as 1-100th of a grain by the circumstance that it is within your own experience that beers are regularly produced with even less quantities than that?—Yes.

10175. And, therefore, it would appear there is no practical difficulty to a brewer nowadays in insuring that degree of purity?—I believe not. I find all the beers now have that quantity, or a less. I do not know whether a larger amount may not be quite permissible; but I know practically this is a limit to which the brewer can work.

10176. Obviously there is no reason why, if such a limit can be secured with a reasonable degree of care, that limit should be raised?—I do not see any reason.

10177. No hardship is inflicted upon anybody?—We do not want to permit him to be slovenly, or say that he shall do anything which is not practical. And therefore I suggest a limit which I know can be practically reached.

10178. Is it those ideas which have led you to suggest the limit of 1-100th of a grain?—Yes; and one other—that the smallest quantity of arsenic which has been in beer to which injurious effects have been rightly or wrongly attributed was, I think, double the quantity. Therefore I think from that point of view I would be on the safe side.

Object of destroying organic matter.

10179. I think you told us on the last occasion you appeared here, that in your opinion the mere presence of the organic matter in the beer does not necessarily interfere with the recognition of the arsenic in beer?—No. In most cases the tests made, with and without destruction of the organic matter, give the same results, not in all.

10180. As a rule, the presence of the organic matter does not inhibit, as it were, the manifestation of the arsenic test?—No, it does not.

10181. And your only reason, therefore, in destroying the organic matter, in the case of having to take large quantities of beer, is not because the organic matter inhibited the formation of the arseniuretted hydrogen, but it was an inconvenient thing to have in the apparatus?—Yes; that is one reason.

Should be done if sulphuric acid is used.

10182. It rendered the solution, I understand, viscous, and difficult to deal with?—Yes; there is a difference in the working of the process without destruction of organic matter, according to whether you use hydrochloric acid or sulphuric acid. When you use sulphuric acid it is better to destroy the organic matter.

10183. In the method prescribed by the Committee, does the examination of wort show any difficulty?—No.

10184. As you prepare your worts they are strongly acidulated, are not they?—I do not think so. We have made worts from sugar solutions, and so on, for testing.

10185. I am talking rather of malt worts?—I have not any experience of malt worts taken from the brewery. I believe my friend Mr. Chapman will have experience of that.

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10186. (*Dr. Whitelegge.*) Do you think of 1-100th of a grain per gallon as being a standard for the guidance of the analyst or as the legal standard?—As a legal standard by which the analyst would have to be guided.

Analyst m allow marg in estimati

10187. You say that the intelligent operator ought to have the responsibility of passing or rejecting samples, knowing exactly how much arsenic is present. If the standard was fixed at 1-100th of a grain do you contemplate any further discretion for him than saying whether there was more or less than 1-100th?—I think so.

10188. What would that further discretion be?—I would myself not like to report against anything which is so little larger than 1-100th as to lie within the limits of experimental error.

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10189. If you find 1-90th?—I would almost certainly, whatever the law might say, pass it. I would probably say 1-90th is so near to 1-100th that in my second experiment I might find 1-95th or 1-105th. Whatever limit the Commission or the law lays down, the operating analyst must have some discretion.

10190. Is it not the practice of analysts in giving certificates to local authorities to have some margin of that kind?—Plainly.

10191. The "discretion" only amounts to this, that you would not think it right to prosecute on anything only slightly exceeding a given standard, partly because it is so near, and also by reason of the experimental error which has to be taken into account?—Quite so.

10192. So that if we find 1-100th of a grain the lowest amount to be regarded as toxic, we must fix our legal standard at something considerably higher, must not we?—Do you mean more severe?

10193. Yes?—It would be a small matter. Whatever limit you may lay down, there will be some discretion of that kind. The 1-100th is so severe, I think, that you might well allow a small divergence from that.

10194. I only want to be clear that in practice it would not work out as a rigid exclusion of all beer containing as much as 1-100th?—I do not think it ought to, not for prosecution. Exclusion means, of course, criminal prosecution, I take it, and I would not like to take that responsibility. I would rather use this as a guide to the brewer, telling him he must work down to 1-100th, but I would not wish to clap him into gaol.

10195. You suggest that the analysts must decide whether the margin is or is not of that kind?—He has naturally nothing to do with the prosecutions, but supposing I found 1-90th, straining the regulations to some extent, I might report that as containing 1-100th. The Police Committee, or whoever it is who has to deal with those cases, decides what excess shall subject the offender to a prosecution.

10196. Do you adopt a practice of that kind in dealing with other foods?—Yes, certainly; there is a limit fixed by law for the strength of spirits, 25 per cent. under proof. If I find it 25.3 under proof, without any scruple whatever, I report that as being 25 under proof. It is so near to the limit of error that there would be no object served in straining the law in that way. A limit has been laid down by the Board of Agriculture as to the amount of water in butter, 16 per cent., a reasonable limit. If I find 16.1 or 16.2 I should not say a word about it.

10197. In what terms would you report in such a case?—That it complies with the law.

10198. Is that the practice amongst the analysts generally?—I believe so.

10199. Is there any understanding amongst public analysts as to the extent to which that discretion goes?—No.

10200. If that is the practice, does it need any special authority in the case of the suggested standard for beer?—No.

10201. If it is already the existing practice as regards water in butter, for example?—I do not know that it is an understood practice. I think every man who has to deal with a practical problem must allow some latitude for variation.

10202. In practice I agree with you that some such latitude is always allowed, and in my experience it has been allowed by the local authority and their legal advisers?—Supposing I found 16.01 or 16.001 of water in butter,

or as many 0's as you like, would I, as the adviser of the local authority be justified in condemning such a sample, or would I be justified in expecting discretion from the local authority to know what all those 0's mean? I, as an intelligent officer, must take the responsibility, and I do take that responsibility upon myself.

10203. I do not think we need discuss it in detail, but I suggest to you that there is an alternative, that instead of saying that it is within the standard limit, it would be possible to give the precise result as you found it with any advice to the local authority that might be proper, verbal or written advice?—Verbal and written advice is often resented by local authorities. They say it is my business to report. If it is a question of a slight deviation from the thing the labour involved would be great. I should have to make many tests instead of one, two, or three, on the average; I should have to go to endless trouble for no object whatever. If you said that 1-100th should be the limit, the officer must have some discretionary limit.

10204. He must read the 1-100th as meaning possibly 1-90th?—He must know best how near he can estimate it. Probably two men would have a different colorimetric limit of error. All these determinations, like the estimation of ammonia in water, are only correct, say, to 10 per cent.

10205. Then the decision of the analyst in regard to a given result, showing an apparent excess over the legal standard, would depend upon his estimate of the accuracy of his own manipulation of that particular process?—Yes, every colorimetric process is so.

10206. Do the local authorities from whom you received samples continue to send you samples of beer now?—No, I do not think they do.

10207. You say very few now?—Very few from the local authorities.

10208. You told us when you were last here that you had met with arsenic in some other food substances?—Yes, quite lately I met arsenic in small quantities in sugar which had not been treated with acid at all. I have also met it in German beet sugar which had been obviously not treated with acid. These sugars are recovered from the lime or strontia compounds by carbonic acid, and if the carbonic acid is obtained from fuel which is arsenical, the sugar becomes arsenical. The sugar used for brewing or treacle making thus becomes slightly arsenical.

10209. Could you say how much was found in these samples of sugar?—I would not like to be definite, but it was about 1-100th of a grain per lb. I will look it up.

10210. Can you mention any other substances besides sugar in which you have lately found arsenic?—No, I cannot; in a good many mineral colours which go into confectionery I found it in some cases. I have lately found it in oxide of manganese, which is used for the same purpose.

10211. In considerable amount?—Yes, 1-10th of a gramme gave a very dense mirror.

Mr. O. Hehner.

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Organic matter of stale beer should be destroyed.

10212. With regard to the destruction of organic matter, I am not quite clear whether as regards beer you recommend that the organic matter should be destroyed if hydrochloric acid be used instead of sulphuric acid?—Not in fresh beer.

10213. You leave that as an alternative to the discretion of the analyst?—Yes.

10214. You do not find it makes any difference in practice?—Not when operating on fresh beer. If the beer gets very stale sometimes the arsenic does not seem to evolve in direct testing. Some time ago I tested a sample of beer which had been made up for the purpose of testing by the committee, and I could not find any arsenic after it had been some months old by direct testing, whilst my friend, Mr. Chapman, destroyed the organic matter of the same sample, and found what had been added. The arsenic had not gone as I had suspected.

10215. Was there frothing?—I do not think so.

10216. The destruction of the organic matter had another object in that case than the prevention of frothing?—Yes. It has an object in some cases when there is frothing; or if the direct marshing is impossible, you have to destroy it.

10217. But there are other reasons I understand?—If a beer had to be kept for some length of time for the purpose of a law case or a prosecution, I would destroy its organic matter if it has become a month or so old.

10218. As a matter of routine, frothing or no frothing?—Yes.

Beer does not lose its arsenic on keeping, but may not yield it to test,

10219. (*Professor Thorpe.*) That is on account of the presence of possible moulds in the beer?—Quite so. I do not know what the explanation is. At that time I thought that the arsenic absolutely went away on keeping the beer, but I have no reason to think it does now. It becomes converted into a form which is not amenable to the test.

being in some organic form.

10220. (*Dr. Whitelegge.*) If due entirely to the action of a mould that would mean some volatilisation?—Not necessarily; only certain moulds evolve volatile arsenical compounds which have a powerful smell. I did not observe any such smell. I imagine that arsenic goes into an organic form, replaces a trace of the phosphorous, etc., in which it would not be discoverable without destruction.

10221. (*Professor Thorpe.*) In other words, I presume you mean that the mould secretes the arsenic very much as the yeast does?—Quite so—not secretes, assimilates it.

10222. I mean assimilates it?—Yes.

10223. Withdraws it from solution?—Yes

10224. (*Dr. Whitelegge.*) You suggest that it not only withdraws it from solution, but converts it into organic forms?—I think so.

10225. So that you do not think of the oxidation of the organic matter as merely causing destruction of the yeast substance or the mould substance which hides the arsenic?—That might be one of the reasons, but it would also break down any organic arsenic compound, if there be any.

Mr. A. C. Chapman.

Mr. Alfred C. Chapman, called; and Examined.

10226. (*Chairman.*) You are an analytical and consulting chemist practising in the City of London, a Fellow of the Institute of Chemistry, and one of the hon. secretaries of the Society of Public Analysts?—Yes.

10227. You formerly occupied for several years a position of senior Demonstrator of Applied Chemistry at University College, London; you are also a Fellow of the Chemical Societies of London and Berlin, and a member of various technical societies and institutes; you hold the position of analyst and scientific adviser to a number of well-known breweries in this country, and have for a period of more than 15 years devoted a very considerable amount of study and attention to brewing and the allied industries, both in their practical and in their scientific aspects?—That is so.

10228. In conjunction with Mr. Hehner, you represent the Society of Public Analysts before this Commission?—Yes, that is so. At the beginning of May, 1902, a letter was received from the Secretary to the Royal Commission, asking for information in regard to the extent to which the method prescribed by the Joint Committee of the Society of Chemical Industry and of the Society of Public Analysts had been adopted, and with what results. For the purpose of obtaining this information, the Secretaries of the Society of Public Analysts were instructed to address a circular letter to all the members of the society, and on May 7th such a letter was sent out in the following terms:

Opinions of members obtained.

> Dear Sir,
>
> The Secretary of the Royal Commission on Arsenical Poisoning has expressed the desire of the Commission to know to what extent the method of testing for, and estimating minute traces of, arsenic prescribed by the Joint Committee of the Society of Chemical Industry and of the Society of Public Analysts has been adopted, and with what results. We should feel obliged, therefore, if you would reply concisely and briefly to the questions contained on the appended slip, returning the same to us in the enclosed envelope at your earliest convenience.

Mr. A. C. Chapman.

13 June 1902.

A meeting of the society will be held on Wednesday, May 21st, at eight o'clock, at the Chemical Society's rooms, Burlington House, to discuss the details of the report, and it is hoped that you may find it convenient to be present.

We are, Dear Sir,
Yours faithfully,
EDWARD J. BEVAN
ALFRED C. CHAPMAN } Hon. Secs.

The questions alluded to in this letter were four in number, and were as follows:

(1) Have you used this method, and if so, to what extent?

(2) Have you found it advantageous, and do you consider it preferable to other methods?

(3) Have you met with any, and if so, what, difficulties?

(4) Have you any suggestions to offer with regard to the better working of the method?

Replies analysed.

To this letter 145 replies have been received. Below I give an analysis of these replies, which I think will supply the Commission with the information for which they have asked.

Total number of replies received		145
(a) Have not tried the method	55	
(b) Have tried the method to a very limited extent, and do not care to express an opinion	12	
(c) Prefer it to other methods, and are quite satisfied with it. Have experienced no particular difficulties, and make no suggestions	34	
(d) Have tried the method, and consider it the best. Have met with difficulties, but do not make any suggestions	19	
(e) Have tried the method, consider it the best, but suggest slight modifications of procedure	16	
(f) Do not consider it preferable to other methods	6	
(g) Doubtful	3	
		145

In reference to (a) it must be remembered that very many of our members are engaged in work (*e.g.*, metallurgical, mineral analysis, etc.) which does not render it necessary for them to test for minute traces of arsenic. This also, doubtless, accounts for the fact that a larger number of replies have not been received.

In regard to (c) I may add that of the 34, 16 tried the method extensively, 14 to a limited extent, while 4 give no information on this point.

Suggestions made.

The most common difficulty which those included under (d) have experienced has been that of obtaining pure acids and pure and sensitive zinc. Several, however, refer to the difficulty of obtaining uniform mirrors as well as the frothing in the case of certain organic liquids.

The suggestions made by the 16 members included in class (e) are, as a rule, of a very trivial character, and do not amount to anything more than a preference for a vertical to a horizontal chloride of calcium tube, to cotton-wool soaked in lead acetate solution rather than paper, or to some particular means for regulating the heating of the "combustion" tube. One member prefers an electrolytic method for the production of hydrogen, and a few others suggest the addition of cuprous chloride, a trace of a ferric salt, or a few drops of copper sulphate or of platinum chloride. In regard to the use of solutions of certain metallic salts for the purpose of facilitating the evolution of hydrogen, I may say that I have made a few experiments which I think throw light upon the retention of arsenic, which is generally recognised to result from this practice. These are briefly referred to below.

Objectors.

Of the members who are unfavourable, one prefers a modification of Gutzeit's method, one prefers his own modification of the Marsh-Berzelius method (which does not appear to differ in any essential point from that suggested by the joint committee), one condemns it in general terms, but adds that "in certain cases it is the best available method," whilst a fourth prefers Reinsch's method for qualitative work, and suggests that "a standard gravimetric process should be substituted" for the Committee method. One member gives no reason for his objection to the process, whilst the sixth member says, "My slight experience leads me to prefer other methods," a preference which appears to be due to his difficulty in obtaining comparable mirrors. From the above analysis it will be seen that out of 75 members of the society who have had sufficient experience of the method to justify them in expressing an opinion, 69 (or 92 per cent.) consider it superior to other methods for the detection and estimation of minute traces of arsenic.

Mr. A. C. Chapman.

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Electrolytic method of applying Marsh test.

10229. You tell us that one member preferred an electrolytic method for the production of hydrogen?—Yes; and that is the gentleman to whom reference has been already made, the public analyst for Nottingham.

10230. Have you examined his process?—I have not examined his process precisely as he carries it out, but I have made a number of experiments in connection with electrolytic methods, and my results have not been satisfactory.

10231. The public analyst in Nottingham did get satisfactory results?—So I presume; but I do not know to what extent he was able to detect traces of arsenic. I do not know what minute quantities he could detect, and with what degree of certainty. In fact, I have had no detailed account of the process as he carries it out, nor of his results.

10232. A slight account of his process has been handed to the Commission, and he considers it quite satisfactory; but he has not given any details as to the degree of minuteness to which the method is applicable. That method, if successful, has the great advantage of doing away with the zinc?—Doubtless.

10233. And also of being very simple—a much simpler affair in the cell containing the substance?—Possibly.

10234. And, if successful, less liable to error through uncertainty in respect to the zinc?—Quite so; but, of course, other errors may come in in that case, due to slight differences of conditions. It might be more difficult with a purely electrolytic method to regulate the conditions within the narrow limits found to be necessary for the success of the process. I can only speak from my own experiments, which have not been very numerous, but have not been very successful.

10235. It might be difficult, but it is possible that it might be ultimately found easy to regulate? It is quite possible.

Insensitive zinc.

10236. Your colleague, Mr. Hehner, had dealt, in his evidence, with various questions of analytical procedure about which we desired information. You have yourself made some experiments throwing some light on the question of the insensitiveness of certain samples of zinc?—I have. I was not the first to whom this occurred. It has been suggested a great many times that the question of the insensitiveness of zinc might be possibly due to the presence in the zinc of certain elements far removed from zinc, in the electro-chemical series, which might give rise to currents, which would be sufficient to cause the deposition of elementary arsenic, rather than its evolution, in the form of arseniuretted hydrogen. In order to ascertain whether there was, in fact, any foundation for this, or whether it could be experimentally demonstrated, I took some zinc which was highly sensitive—that is to say, which would with absolute certainty and ease show 1-500th of a milligramme of arsenious oxide—and spotted this sensitive zinc in places with metallic platinum by putting on platinum salt, or metallic silver, or metallic copper. I found that when the Marsh-Berzelius process was used with the spotted zinc, instead of the ordinary zinc, there was a reduction in the amount of arsenic obtained. The spotted zinc gave in each case appreciably smaller mirrors. I am not prepared to say the explanation I have suggested is the exact one, but, at any rate, those are the actual facts, and I think they are suggestive. I may just show you the tubes which illustrate that point. The first four were made with 1-200th of a milligramme, and the last three with 1-500th, and in that case you see the platinum has kept the whole of it back, while the copper has kept back very nearly the whole of it.

10237. In what quantity?—In about 30 or 40 cubic centimetres of liquid in the Marsh flask.

10238. What would the 1-200th of a milligramme correspond to in respect to grains per gallon? In four cases you had 1-200th of a milligramme present in the solution?—Yes.

10239. How many cubic centimetres of solution in those cases?—About 40 cubic centimetres altogether—the total liquid in the flask.

10240. In the three cases of 1-500th of a milligramme, did you have about the same quantity of liquid?—Yes, about 40 or 50 cubic centimetres.

10241. Did you measure the quantity accurately?—No; it was about 50 cubic centimetres.

10242. The zinc spotted with platinum gives, perhaps, a rather fainter mirror compared with zinc spotted with silver?—Yes, less arsenic came out than with silver.

10243. When the zinc was spotted with copper the mirror was slightly stronger than when spotted with silver?—Possibly; but that, of course, would be probably within the limits of experimental error.

10244. You would scarcely reckon it a difference?—I should be scarcely inclined to call that a difference.

10245. Then the unspotted zinc gave a slightly stronger mirror than the others?—Yes.

10246. Those were all with 1-200th of a milligramme?—Yes.

10247. Now take the three cases of 1-500th of a milligramme. The zinc spotted with platinum and the zinc spotted with copper gave nearly equal mirrors?—This light is not very good, but I think you will find that the platinum-spotted mirror is less than the copper.

10248. The mirror produced when the zinc was spotted with platinum is very slightly stronger than when it was spotted with copper?—The top one is the platinum one, which is very nearly free—there is scarcely any mirror there.

10249. With unspotted zinc the mirror was stronger than either of the others?—Yes. May I be allowed to say one thing in reference to this, that the point of these experiments is rather to show the inadvisability of adopting the suggestion made by a few of our members who replied to our questions. It shows the inadvisability of adding either platinum chloride or copper sulphate or any other metallic salt to the Marsh flask for the purpose of increasing the evolution of the gas.

10250. I ventured to make the same suggestion to Mr. Hehner, and he gave an answer quite conformable to the effect you have mentioned. The behaviour of some samples of arsenic-free zinc seems to be capricious and uncertain?—That is so. I venture to think, possibly, that these experiments throw some light upon that behaviour.

10251. You think that these experiments show that the capriciousness may have been due to the presence of metallic and other impurities in the zinc?—I do.

10252. Do you think that those agents, setting up powerful galvanic currents locally, might suffice to cause arsenic to be deposited from solution in an elementary condition?—I think it possible.

10253. You are afraid that the pure electrolytic process, such as the public analyst at Nottingham followed, might be liable to that fault?—I think it quite likely.

10254. Did he give some evidence before your committee?—He was one of our members who replied to the circular letter which we sent out asking for information.

10255. Has his method been considered by the committee?—We have had no evidence with regard to his method put before us.

10256. He sent a mirror with the description of his method. You would consider that his method ought to be carefully examined and repeated?—Yes.

10257. It would be right to examine into it?—Most emphatically.

10258. And to repeat it, and find whether it does give the full strength of mirror that can be had by the zinc process?—Most certainly it ought to be inquired into.

10259. If it gives as strong a mirror with the same quantity of arsenic in the substance as the zinc process gives, then you would think it might be considered for adoption in preference to the zinc process?—Precisely, unless it happened to be much more laborious in execution.

10260. What proportion of public analysts are members of the Society of Public Analysts?—I cannot give you the exact number; but we have about 300 members, and of those 300 about 88, I believe, are public analysts.

10261. I see that out of 145 asked, 55 have not tried the method, and 12 have tried the method to a very limited extent, and do not care to express an opinion. Do these small numbers that have had experience with the method mean that public analysts largely use other methods, or does it mean that they are not getting beer to test?—I cannot answer that definitely; but I presume it means they are not getting beer to test. I think my friend, Mr. Hehner, gave some evidence on that point—that probably public analysts are not receiving so many samples now as formerly.

10262. What is your practice with regard to the destruction of organic matter?—I destroy the organic matter in all cases. Destroys organic matter both in beer and malt.

10263. Both in beer and in malt?—Both in beer and in malt.

10264. If you did not destroy the organic matter, would the Marsh process not work well?—No. I am accustomed to use sulphuric acid, and when using sulphuric acid the presence of organic matter does most certainly, as Mr. Hehner has said, prevent some of the arsenic from being obtained. It keeps it back.

10265. Then the sulphuric acid that you use in the process would not be sufficient to destroy the organic matter?—No; that is destroyed, first of all, by treatment with strong sulphuric acid and nitric acid. Uses sulphuric acid.

10266. If the organic matter is not destroyed the Marsh-Berzelius test would be still applicable, but liable not to give such good results?—With sulphuric acid I should say it would not be applicable at all in very many cases. With hydrochloric acid, yes, in many cases.

10267. Where would the failure be?—The arsenic would not come out. I am speaking, of course, of very minute quantities.

10268. You consider that these very minute quantities are forcibly held by the organic compound, and do not come out in response to the Marsh test?—I do not know what the explanation is, but it certainly is a fact that using sulphuric acid in the presence of organic matter one does not get by any means the whole of the arsenic. In some cases one gets a very small proportion of it.

10269. But if the organic compounds are all thoroughly broken down, then the arsenic does respond to the Marsh test?—Yes.

10270. Do you know whether it is usual with analysts generally who use the Reinsch test to break down the organic matter, or do they not destroy the organic matter?—I cannot say what is the usual practice. I used the Reinsch method extensively at the time of the Manchester outbreak, and I did not destroy the organic matter. I Reinsched the beer directly.

10271. With the Reinsch it is not so necessary to destroy the organic matter?—I believe not. I think I should be right in saying that.

10272. As a brewer's chemist, you accept the committee's method as a good one?—Most certainly I do. As brewer's chemist, accepts Committee's test.

10273. But you would not be unwilling to see it improved, if a purely electrolytic method could improve it?—I should rejoice to see any improvement.

10274. What limit do you find it practicable to work to in respect of the quantity of arsenic per gallon?—In the case of beer I should say one could certainly detect 1-400th of a grain per gallon without working on an unduly large quantity. Its delicacy.

10275. (*Dr. Whitelegge.*) Is that without concentration?—No, in this case it is concentrated. I should destroy the organic matter, and have a smaller volume of liquid

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10276. (*Chairman.*) As advised by you, can brewers produce uniformly beer under 1-200th of a grain of arsenic per gallon?—I should say yes.

Beer usually contains much less than 1-200th grain.

10277. You can so arrange with brewers that you advise that the beer shall not contain more than 1-200th of a grain per gallon?—I can say that of the very large proportion of the samples of beer submitted to me by private clients, the very great majority do not contain anything like 1-200th of a grain per gallon, but much less.

10278. Do you think a regulation that a beer shall not contain more than 1-200th of a grain per gallon would be workable, as a rule?—I think that would err on the side of being too severe.

Official limit of 1-100th practicable for brewer.

10279. Would you think that a condition of not more than 1-100th of a grain per gallon would be too severe?—Not by any means.

10280. Would it be sufficiently severe?—That is purely a medical question. So far as the analytical procedure is concerned, it would not by any means be severe, nor as regards brewing practice would it be too severe. I cannot answer with regard to its possible effect on health.

10281. It would not be advisable from the brewers point of view to make the limit as far as 1-200th?—No.

Malt usually less than 1-300th.

10282. What minimum of impurity can you secure in the case of malt?—I had perhaps better answer that question by giving my own personal experience of the samples of malt submitted to me by maltsters. I should say that the very large majority contain less than 1-300th of a grain per lb. even now.

10283. Would you say, as Mr. Hehner said, that malt might be secured in practice with no more than 1-500th of a grain per lb.?—Yes. My own experience confirms that. I think Mr. Hehner was quite right.

10284. And that would not be too severe a regulation in respect to malt?—I think not.

10285. Do you ever find arsenic in glucose or invert sugar now?—In invert sugar very rarely indeed; in glucose occasionally in imported samples.

10286. How much do you sometimes find in glucose now?—As much as and not more than about 1-300th of a grain to the lb.

Glucose less than 1-300th

10287. Do you think that glucose might properly be required to contain not more than 1-300th of a grain per lb.?—Most certainly. 95 out of a 100 probably contain a great deal less than that.

10288. It would be quite a practicable and tolerable limit to say that glucose must not be used if it contains more than 1-300th of a grain per lb.?—I think so.

10289. Do you regard the purchase of malt and fuel on a guarantee that it does not contain more than a standard limit of arsenic to be a practicable and satisfactory proposal?—Provided a reasonable limit was adopted, I think it would be—I mean by that, providing the limit is not too severe.

Official limit should be imposed on product, not on ingredients.

10290. (*Sir William Church.*) Following up what Lord Kelvin has been just asking, are you in favour of having standards of purity for the materials from which beer is brewed, or only for the finished product?—I think it would be much simpler and more satisfactory if a limit were formally fixed for the finished product and not for the constituent materials.

10291. And that you think would be a perfectly sufficient safeguard for the public, and you would leave it to the brewer to see that he used pure materials?—Certainly.

10292. Without having any standard laid down by law?—Certainly.

10293. Might I ask you how many circulars you sent out?—We sent circulars to all the members of the society, about 300.

10294. I see you have received answers, pretty complete answers from 34, and from 19 who have also used it, and from 16 and 6—that amounts to 75. You say you think roughly from 80 to 90 of your members are public analysts?—That is so.

Replies from Society.

10295. So that probably you have received answers from 60 or 70 of your members who are engaged as public analysts?—Probably.

10296. Of course the large number of 55 who have not tried the method are probably men who are engaged in mineralogical and other work which has nothing to do with the production of beer?—Quite so.

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10297. And probably they have not been in the habit of testing these organic substances for arsenic?—That is probably the explanation.

10298. So that we may take it really that the 75 answers you have received express pretty fully the views of those of your members who are engaged in public analytical work?—I think so.

Sensitiveness of zinc; effect of platinum and copper.

10299. (*Professor Thorpe.*) I should like to have in some greater detail the experiments you made as to the effect of adding copper and platinum and silver?—May I tell you exactly what I did. I took the ordinary Marsh apparatus such as is described in the Report, and I then took some zinc, which I knew to be sensitive, which I knew whenever I added 1-500th of a milligramme of arsenious oxide would always produce a mirror which corresponded with that, and, therefore, the zinc did not retain any of the arsenic. I took some of the same zinc, and the same quantity, and put on to that with a sharp pointed rod very minute drops of some copper salt, or silver salt or platinum salt, and so got minute spots of the metal on the surface of the zinc. That was thoroughly washed and employed in another test precisely similar to the one that gave the 1-500th. Those tubes, which I think you have seen, show the amounts of arsenic, the depth of the mirror obtained, working with the zinc so spotted. Whereas 1-500th of a grain came out fully when nothing had been done to the zinc, when the zinc had been spotted with these metals less than 1-500th came out. Platinum exercised a greater inhibitory effect, and retained more of the arsenic than silver or copper. So noticeable is it that in the case of the 1-500th nothing came out at all with platinum. It was virtually blank.

10300. I think you gave us an explanation of what you imagined went on. You think the arsenic was deposited as arsenic on the copper?—I venture to think that is a possible explanation. I am making some experiments, in conjunction with my friend, Mr. Hehner, which may throw more light on the actual cause. I put these experiments forward for what they are worth, as showing the inadvisability of adding metallic salts to the Marsh apparatus for the purpose of increasing the flow of hydrogen.

10301. Do those comprehend all the experiments you have made?—Yes; of course, I have made other experiments than those represented by the tubes I have shown you. I have made two other series in the same way with similar results. One series which I did not purposely bring with me, give rather more striking results than those.

10302. The idea that copper might under certain circumstances act detrimentally would occur to anybody who investigated the method. It occurred, for example, to myself. Assuming I was using a substantial quantity of copper, and that I was operating in hydrochloric acid solution, and there was a substantial rise of temperature, I might be unknowingly Reinsching the solution?—Precisely.

10303. I wish to guard against the possibility of that error. I may say, however, that Mr. W. Thomson, of Manchester, who was examined here some little time ago, told us that he made a constant practice of adding copper salt to his materials. The only inhibiting metal to which he drew our attention was iron. He told us that for that reason he frequently found it impossible to use Brunner, Mond's zinc on account of the relatively large quantity of iron it contained. Certainly he led us to believe there was no detrimental effect exerted by copper in preventing the evolution of arseniuretted hydrogen. I may say that is rather our own experience in the laboratory. I did not really know that this question was going to come up, but I have brought down a series of tubes placed side by side, showing the effect of either adding or withholding copper sulphate to beer containing known quantities of arsenic, and certainly our general conclusion is that copper does not exercise any very serious detrimental effect, and certainly has, in the case of zinc with a high degree of purity, naturally a very considerable effect in promoting the evolution of hydrogen?—I think if you look at the tubes I have brought you will see that whilst platinum produces a very marked effect, copper produces only a very slight

effect. I venture to think it is quite possible that the amount of effect produced would depend upon the distance of the zinc from the other element in the electrolytic series.

10304. The only tube which shows any departure happens to be one in which platinum chloride was selected, but as regards copper, which is the one all chemists are inclined to adopt, I venture to think the analytical evidence goes to show there is no very serious detrimental effect?—There is no serious effect, but probably there is an effect which is very slight.

10305. Have you made any examination of wort?—I have.

10306. By your methods?—Yes.

10307. I mean malt worts?—Yes.

10308. Or even raw grain worts?—Malt worts in a few cases.

10309. Do you find there is any special difficulty in treating those by what I may call the Committee's method?—None whatever. Of course I destroy the organic matter.

10310. Is that your invariable practice?—Yes.

10311. In that case you would have no difficulty. You have never made experiments without destroying the organic matter?—Not in the case of worts, but in the case of beers and malts or the extract of malts.

10312. What is your experience?—Using sulphuric acid, I could only get a portion of the arsenic that is obtained when I destroy the organic matter.

10313. Do you meet with any practical difficulties in the way of excessive frothing of the material?—In that case, no. By malt extracts I rather mean a liquid extract obtained by treating the whole malt with acid, the washing of the malt, as it were, not the mashing of it.

10314. Have you tried to make a malt wort as a brewer would make it, simulating the process of the mash-tun, and putting that wort into your apparatus?—I have never done that directly.

10315. Are you familiar with the interim report of the Commission?—Yes.

10316. You will perhaps remember that their recommendation was as to the Board of Inland Revenue, viz., that they recommended that the Board of Inland Revenue should possess and exercise powers to prescribe a test, and, if necessary, to enforce a penalty?—Yes.

10317. It has been suggested to the Committee which is engaged in carrying out the wish of the Commission that, as regards the penalty, it would be more satisfactory to everybody if that penalty were directed to the wort, that the wort should be that which took the offending brewer into court, not the finished beer. Do you see any difficulty about that?—No. Apart from the difficulty of analytical procedure, I see no reason why that should not be done.

10318. It is pointed out that it is eminently desirable, if you can, to stop a man at an early stage of his process. It is rather hard upon him to wait until the whole thing is completed before you pull him up. It would be more convenient to take him at some intermediate stage, and for all practical purposes would be as good as any other stage for carrying out the spirit of the law or regulation. Therefore it has been suggested to the Committee that the wort should be the thing to be examined, and the penalty, if necessary, should be inflicted upon the finding of the wort. As a practical man, do you see any objection to that?—Do the Committee suggest that the sample of wort should be taken before fermentation or towards the end of the fermentation? The Committee will doubtless have in their minds the removal of small quantities of arsenic by the yeast.

10319. The suggestion made to the Committee as regards the brewer was perhaps the hardest that could be devised, namely, that it should be taken before fermentation, immediately from the mash-tun, which is of course a much more stringent test than it would be after fermentation?—Certainly.

10320. You see no difficulties, as a practical man, in carrying out that suggestion, do you?—No: I see no difficulties.

10321. One additional reason that was put before us for taking the wort was that the brewer would be judged by a better representative sample of his output than on any given sample of malt that might be picked up. There are obvious difficulties in sampling malt?—Quite so.

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10322. If you take him upon the extract of the malt, you would probably get a better average specimen of his output?—That is quite true. I think it would be very difficult, and in some cases rather unfair to the brewer, to hold him responsible for quantities of arsenic found in the malts owing to the difficulty of getting homogeneous samples.

10323. But taking it from the wort largely minimises these difficulties?—Certainly it does.

10324. (*Dr. Whitelegge.*) I want to ask a question on the point Dr. Thorpe has touched upon. You think it is not necessary to define any other standard than for wort or finished beer, as the case may be?—I do not think it would be necessary.

Brewers' control over ingredients.

10325. You would not think it proper for a brewer to exercise any watch over his ingredients in terms of conforming or not conforming to a given standard that might be prescribed?—I think it would be certainly right and proper for every brewer to watch his materials, and I think every brewer worthy of the name would so watch his materials; but I do not think it would be necessary or wise to fix the standard for those materials.

10326. In what sense would you expect him to watch—to obtain a certificate of purity in any way?—I would suggest he should rather employ a chemist, or should obtain from the persons from whom he purchases his materials sufficient guarantees with regard to the purity of his materials. It would be in his own interest to do so. If by chance any sample of wort were found to show a large quantity of arsenic, that amount of wort would probably be lost to him, and it would be to his own advantage to see that the materials were sufficiently pure to give him wort within the limits prescribed by the Commission.

10327. It is necessary in his own interest, apart from the question of public health, that he should exclude arsenic from his ingredients?—As far as possible.

10328. Should he not have some sort of guide as to the amount of arsenic that should condemn these materials?—That, I presume, would be afforded to him both by experience and by the help of his scientific advisers.

10329. The suggestion has been made to us that 1-300th of a grain per lb. in the case of malt should be the standard?—I think that is not an unreasonable limit.

10330. Would you think it the duty of the brewer, in his own interest and in the public interest, to have malt not containing more than that?—I think so.

10331. In other words, he must watch over it under proper advice?—Precisely.

10332. Where are we placed by the suggestion that he shall be only taken into court on the finished beer or the wort? As I understand you now, he must still look to a certain standard, legal or otherwise, in the case of the ingredients?—Yes.

Objection to official tests for ingredients.

10333. Does the suggestion amount to anything more than that he shall not be prosecuted, however much arsenic the malt may contain, unless it leads to the production of wort containing more than the permissible limit in the case of beer?—That is what it amounts to.

10334. So that, as a matter of protecting the brewer from being harassed, your suggestion would be that he is expected to watch all these things, but if he fails as regards ingredients, however great that failure may be, he must not be prosecuted for it. It would come to that, would it not?—That is what it amounts to.

10335. Do you think there is very much gained by adopting that suggestion?—Certainly I think there would be if a reasonable limit were prescribed in connection with beer, which would be applicable to beer or to wort. The brewer himself would if, owing to carelessness or to some other cause, he used highly contaminated coal, be a loser pecuniarily. If a limit or limits were prescribed in reference to the materials used, then owing to the extreme difficulty of obtaining perfect samples in the case of malt and hops, he would be liable to prosecution in connection with the material, owing to the fact that it possibly had not been carefully sampled. In other words, he would be improperly, if I may use the expression, harassed

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10336. I think you told us that it was easy to secure malt free from a greater proportion of arsenic than 1-300th of a grain per lb.?—Yes, when properly sampled.

Difficulty in sampling malt.

10337. Where does the harassing and injustice to the brewer come in if he is told that he is contravening the law if he uses a malt which, when properly sampled, contains more than 1-300th of a grain per lb.?—Because the difficulty is to secure proper samples in the case of malt and hops. Experience has shown that, whilst in the majority of cases you can get a representative sample, yet there are other cases in which it is extremely difficult. The trace of arsenic which is deposited in the kilns may be deposited in an irregular manner or in one particular place where a current of air has brought down dust, and if by some extraordinary chance that particular lot was taken for analysis, then proceedings might be instituted against that brewer.

10338. But does not that tend to show that the method of sampling needs to be defined?—Probably it would; but I think it would be extremely difficult to procure a proper sample, say half a pound or a pound sample, from 5,000 to 10,000 quarters of malt.

10339. So that you would rather modify what you said as to the 1-300th of a grain, would not you? 1-300th of a grain would depend upon a rather academic method of sampling?—When I suggested 1-300th I had no idea that would be suggested as a legal limit. I was rather asked the question, I thought, whether it would be possible to work down to that, and I said, "Yes, it would be possible." I did not mention that quantity with any reference to a legally fixed limit.

10340. Now I understand you to say that if it became a legal limit it would be necessary to have defined conditions as to the method of sampling?—Most certainly it would.

Not in sampling glucose.

10341. In the case of glucose, is there any difficulty in sampling?—It is not by any means so great.

10342. Would you say it would not matter if a brewer used glucose containing however much arsenic, if the wort into which that glucose entered did not contain more than the prescribed limit? The difficulty of sampling vanishes here, does it not?—Yes.

10343. Ought the brewer to be at liberty to use an arsenical glucose, provided he does not produce an arsenical wort?—If a limit is fixed in connection with wort, I must confess I do not see how it would affect any single person, whether one of the materials employed contained 1-10th of a grain or 1-500th of a grain, provided that the amount of arsenic found in the finished product was below what would in the minds of this Commission be considered a safe limit.

10344. I think we agreed just now that it was the duty of the brewer to watch his ingredients?—Yes, in his own interests.

10345. And also in the interests of the public health, is it not?—Certainly.

10346. Then if he fails to exercise that watch over the ingredients—if it is the duty of the brewer to watch his ingredients—it is not quite immaterial if his precautions break down in respect to one of the ingredients. It must add more arsenic to the finished beer if an ingredient is allowed to contain arsenic in greater proportion than is absolutely necessary?—But, provided the finished product does not contain more than the Commission's safe limit, I do not see what the precise composition of the materials employed has to do with the case. The whole thing is simply this: If you suggest 1-100th of a grain in the finished beer as the safe limit, I say that so far as the public is concerned, I do not see it matters much what the composition of the materials may be. I merely gave expression to my opinion that brewers would, as intelligent and careful manufacturers, for their own satisfaction and protection, take steps to see that the articles with which they were supplied were reasonably and properly pure.

10347. I understand you now to accept the suggestion of Dr. Thorpe's Committee, and to say that it would not matter if the ingredients contained more than was necessary of arsenic provided that, when averaged and diluted in the finished material, the standard defined is not exceeded?—Yes, I think that is the meaning of Dr. Thorpe's suggestion.

10348. (*Professor Thorpe.*) I hope I shall not be misunderstood; it is not my suggestion?—I understood it was the suggestion brought forward by the Committee.

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10349. (*Dr. Whitelegge.*) Dr. Thorpe said just now that it was in a way making it more severe on the brewer, and at the same time arriving earlier at the detection of the arsenic if instead of examining the finished beer or fermented wort you went to the wort before fermentation?—It is safer for the brewer.

10350. And arrives at a conclusion earlier?—Yes.

10351. But you would not say that the same advantage arises in going still earlier into the ingredients?—I do not see that it does.

10352. You spoke of the difficulty of sampling as extending to the malt, but not extending, as I understood you, to the glucose and sugars?—Not to the same extent.

Difficulty in sampling fuel.

10353. In the case of coal, would you say the difficulty of sampling is considerable?—It is enormous.

10354. You advise brewers as to the selection of their fuels in addition to other points?—I do.

10355. Do you give them any advice as regards the use of fuel?—I do. In general terms my advice to them is to use the best selected anthracite. Coming to details, I recommend the anthracite from certain collieries which I have repeatedly tested, and know to be as free from arsenic as any anthracite ever is.

Guarantees with fuel of little value.

10356. Do you make any recommendations to them as regards certificates of freedom from arsenic to be obtained with the fuel?—No. I have very little confidence in such certificates.

10357. Do you advise them to send samples to you for analysis?—I do.

10358. What amount of sample do you ask them to send?—About 10lbs. of coal.

10359. Is that picked?—Yes, picked under my instructions.

10360. By the brewer who sends it to you?—It is a sample taken by the brewer who sends it to me.

Advice as to selection of fuel.

10361. It is freed from pyrites to a considerable extent?—No. I tell him to take large lumps representing as fairly as he can the truck load, or whatever it may happen to be, and to break these up into smaller lumps, and mix them up. Certainly not to take out a brassy or pyritic piece.

10362. That is for the purpose of sending to you?—Yes.

10363. For the purpose of using it himself, do you recommend him to pick out any?—Yes, to reject any portion which is brassy in appearance or unusually heavy.

10364. Do you advise him to ask for it to be picked before it comes to him?—Yes, in all cases.

10365. And to pick it himself?—Yes, to take a fair sample for me, and to select for his own use. My report is against the sample.

10366. What would lead you to say that a given sample is too arsenical or to pass it?—I do not care to give figures, because coal varies very much. If you press the point I will give you a number, but I would rather not.

10367. Would you rather rely on the selection of the colliery and the careful examination and picking of the coal than on any certificate?—I should prefer to have both. I meant to say that the certificate which was sent out in a printed form by all colliery offices are things I attach comparatively little importance to; but the certificate I do attach importance to is that which is obtained by the scientific advisor to the firm in question, working on a sample taken as I have indicated. To that certificate I attach great importance.

10368. You heard Mr. Hehner's evidence?—Yes.

Margin necessary in estimating by Committee's test.

10369. I gathered from him that if you were working to 1-100th standard it would be necessary in deciding whether a given sample was to be returned as complying with that standard or not, to take into account the experimental errors?—I hold no public analyst appointment. Every analyst would use his own discretion.

10370. You agree with Mr. Hehner that it is necessary to take into account experimental errors?—Certainly.

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10371. Can you say what range of experimental error you would consider to be proper in the case of the Joint Committee's test?—I think the example Mr. Hehner gave was a good one. With a limit of 1-100th of a grain working under the Sale of Foods and Drugs Act I should certainly hesitate to initiate proceedings if I found 1-90th. I should consider a figure such as that would come within the range of experimental error. It might be 1-90th or 1-105th. If I found 1-50th I should obviously have no hesitation. *Mr. A. C. Chapman.*

10372. Do you think 10 per cent. on each side would be a reasonable range of error?—Roughly speaking, I think so. The analyst uses his discretion, bearing in mind the particular nature of the sample and a number of other things one cannot perhaps go into. 13 June 1902.

fessor pine.

Professor DELEPINE called again. *Professor Delepine.*

10373. (*Chairman.*) I understand that you can give us some further evidence on a number of points relating to our inquiry?—Yes.

ity of e which nay get glucose.

10374. You mention first a calculation of the amount of arsenic which could be introduced by brewing sugar?—Yes. I have calculated that glucose, such as the arsenical glucose No. 23 (Table IV. of Appendix to my previous evidence), might introduce as much as 2·1 grains of arsenic in 1 gallon of beer, supposing that only 5 per cent. of glucose had been used in brewing. That sample of glucose contained 6,000 parts of arsenic in 10,000,000 parts, or about 4·2 grains of arsenic per pound (according to estimation made for me by Dr. Coutts by means of my method). In order to find whether the above calculations gave an approximate idea of what actually takes place in brewing, I had some beer brewed in the laboratory, using as a malt substitute, glucose obtained from Brewery A, and which had been originally supplied by Bostock's. This glucose was collected a little later than Sample 23, but it had the same characters, and contained also 6,000 parts of arsenic per 10,000,000. It had been extensively used in Salford up to the day on which I discovered the danger connected with its use. The wort I had at my disposal contained distinctly less than 1 part of As^2O^3 per 10,000,000 (*i.e.*, less than 1/143 grain say about 1/200 grain per gallon), probably derived from malt. A quarter of a pound of glucose containing 4·2 grains of arsenious acid per pound added to this wort would, on the supposition that the whole arsenic contained in the sugar passed into the finished beer, be sufficient to introduce 1 grain of arsenic into a gallon of beer. But I have shown that yeast, even when it contains already a fair amount of arsenic, is capable of taking up a considerable amount of the poison, and I calculated that more than a ½lb. of the glucose would be necessary to introduce 1 grain of arsenious acid in the finished beer. I had found that yeast containing 80 parts of arsenic per 10,000,000 parts was capable of removing 500 out of 1,000 parts of the arsenic contained in the arsenical wort, in the course of four days fermentation. The yeast at my disposal contained 66 parts of arsenic per 10,000,000. It was therefore probable that the yeast would remove rather more than half of the arsenic introduced into the wort by the glucose added to it. To secure the presence of 1 grain of arsenic in our finished beer it was therefore necessary to add about ½lb. of the glucose in question to each gallon of wort. This was done, and the finished beer obtained after four days' fermentation was found on analysis to contain 130 parts of arsenic per 10,000,000 instead of the 140 parts which I desired to obtain (that is, 0·91 grain per gallon instead of 1 grain). Considering the difficulty in calculating exactly the amount of arsenic which the yeast would remove, the result was satisfactory, for it showed that arsenic can be introduced into the beer through arsenical glucose, and that the quantity of arsenic found by analysis in the finished beer may correspond very nearly to that introduced with the brewing sugar, allowance being made for the removal of a certain proportion of it by the yeast. This beer given to rats proved quite as noxious as other arsenical beers. No smell of cacodyle could be discovered during the fermentation, nor could any cacodyle be demonstrated by methods (for instance, treatment by hypophosphorous acid) which reveal even small quantities of that substance. This beer behaved exactly like other arsenical beers when tested by Reinsch's or Marsh's methods. This experiment therefore confirmed entirely the views I advanced in 1900 regarding the relations existing between the amount of arsenious acid in glucose and in arsenical beer.

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10375. You have next some further particulars to give with regard to the quantitive use of the Reinsch test, by the comparison of sublimates with standard sublimates?—Yes, I have thought it desirable to complete further the statements which I have previously made as to the methods I adopted for obtaining sublimates, so that there should be no doubt in your minds as to the precautions which I have taken to make the results comparable. I omitted to mention previously how I obtained sublimation tubes of a uniform size, a matter which is of great importance in the quantitive method which I have devised. Thin glass tubing with an average bore of 3 millimetres is used. In the first few experiments I found that although soft glass is often contaminated with arsenic, it could be still used for the purpose of making sublimation tubes. I took at first a considerable amount of trouble in getting thin tubing of hard glass, but my assistant found on trying soft tubing that it was possible to get very good results with them, and I ceased to trouble about the question of hard glass. This glass tubing is cut into pieces about 2½" long, each piece is then tested with a cylindrical steel rod, a little under 3mm. in diameter. All tubes which do not admit this rod are rejected. The selected tubes are then further tested by means of a brass plate with a circular opening measuring 3½mm., ⅛ in diameter, and only those tubes which pass through that aperture are finally adopted. The tubes are then thoroughly cleansed. With these selected pieces of tubing minute test tubes measuring about 1¼in. in length are made. By this means sublimation tubes of uniform diameter and with walls of tolerably uniform thickness are obtained. It is essential in order to obtain good results that the tubes should be thoroughly cleaned. One almost always finds that there is a somewhat crystalline deposit coating the walls of these tubes, and this coating is capable of partial sublimation on heating. Whether it is arsenic one has to deal with or not is difficult to say, but there is no doubt that some minute crystalline bodies resembling crystals of arsenious acid are found inside these tubes when they are examined microscopically. The tubes are therefore thoroughly cleaned, first with distilled water, secondly with absolute alcohol, thirdly with ether after which they must be thoroughly dried and kept in a dry dustproof place. The cleaning of these tubes is a matter of very great difficulty. Simple washing will not do; it is necessary to use a kind of plug of cotton moistened with the fluids I have mentioned, and swab the inside of the tube very firmly. The small squares of copper (6 millimetres square) upon which the arsenic has been deposited are washed with pure absolute alcohol, pure ether, thoroughly dried, and cut into three narrow strips. The tube is gently warmed to drive off any moisture, the strips of copper are dropped into it, where they must lie side by side, and all reach the bottom of the tube. The tube is then heated by bringing it above the point of a very small flame. The copper may thus be heated to a dull red heat without the glass being deformed through softening. When arsenic is present a small sharply defined ring of crystals forms immediately beyond the copper. When the quantity of arsenious acid contained in 100 cc. of solution does not exceed 1/100 milligramme, the ring of crystals is invisible, or barely visible, to the naked eye, but when the amount exceeds 1/50 of a milligramme the ring is at once apparent when the tube is examined in suitable light. Any over heating is attended with a spreading of the sublimate which renders comparison between various sublimates difficult. It is, however, for each observer to conduct the sublimation in such a way as to obtain results which will be comparable amongst themselves. May I show you some sublimates obtained in this way with definite quantities of arsenic, in which it will be possible for you to see the differences in the sublimates obtained. The small pieces of copper which I use are of the same size, but minute differences do not have apparently any very great effect upon the results, because the arsenic is capable of depositing in various thicknesses on the metal. This is a sublimate containing 1 part in 10,000,000 of arsenious

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acid, and cannot be seen very well with the naked eye, but is visible under the microscope. This other was obtained with 3 parts of arsenious acid to 10,000,000 parts of beer, and it is practically impossible to see it by transmitted light with the naked eye. When you come to 5 parts in 10,000,000 the sublimate can be easily seen, especially when the tube is placed against a dark surface and light is allowed to fall upon it in an oblique direction.

10376. These sublimates consist of arsenious oxide?—Yes.

10377. What is inside this small tube?—The sublimate which has been obtained from one of those pieces of copper.

10378. This is what might come from a piece of copper coated with arsenic like that we see?—Yes. I always use two pieces of copper, one for keeping or for control and one for sublimation. I have stated that I believe my standard sublimates are reliable, and that they keep long enough to be used in practical work. With regard to the first point, Dr. Coutts, who was then my assistant, and myself have on three different occasions, at intervals exceeding six months, prepared sublimates from arsenic-free beer containing definite quantities of pure arsenious acid. The sublimates prepared at these intervals from solutions containing the same amount of arsenic have corresponded very closely. Sublimates obtained from 100cc. of beer containing 1-100th of a milligramme of arsenious acid have invariably been less abundant than sublimates prepared with 2-100th milligramme. With quantities exceeding 8 or 10 hundredths of a milligramme dissolved in the same quantity of fluid, the sublimates obtained were a little more variable. But, as I have pointed out before, my method is based on the appearances presented by *sublimates obtained from minimal quantities of arsenic*, because when the quantity of arsenic is small, the crystals composing the sublimates are almost uniform in size and pretty equally distributed. When larger quantities of arsenic are sublimated the appearance of the sublimates is frequently modified by the formation of larger crystals, which are not so uniformly distributed as the smaller crystals. In order to find out the limits within which estimations could be carried out by the comparison of sublimates, I have had a series of sublimates prepared from solutions containing respectively 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, and 20 hundredths of a milligramme of As_2O_3 per 100 cc. of fluid. In each case only 100 cc. of fluid was used in applying the test. The coppers corresponding to the odd numbers were sublimated on one day, the other coppers corresponding to the even numbers were sublimated on a subsequent day. Dr. Coutts and myself, independent of one another, arranged the sublimates in order of density, and we had no difficulty in arranging each group of sublimates in an order corresponding exactly to the quantities of arsenic which had been added to the fluid. This gave us two series in which there was a clear ascending scale, any degree being distinguishable from the degree above and the degree below it. Then we independently compared the two series of sublimates and found that up to 7-100 of a milligramme the two series were in perfect agreement. Above 7-100 mg. a difference of 1-100th of a milligramme could not always be appreciated. Thus it was not easy to determine which sublimate was the more abundant of the one prepared from 9-100 milligramme and from the one prepared from 10-100th. The difference between 8-100th and the 10-100th was, however, quite obvious. All through the two series the difference between the two adjacent degrees of the scale became slight when the quantities of arsenious acid exceeded 4 or 5 hundredths of a milligramme. On the other hand the difference between the degrees corresponding to 1, 3, 5, 7, 9, and 2, 4, 6, 8, 10 hundredths of a milligramme, respectively, were sufficiently clear to make it possible to determine whether a sublimate obtained from a solution of unknown strength belonged to one interval or another. The original sublimates prepared at the end of 1900, and corresponding to 1-100, 5-100, and 10-100 milligrammes, even after being preserved for six months, differed so little from the fresh sublimates that an error of more than 1-100 milligramme would have been difficult to make. With carefully prepared sublimates the error need not exceed 1-100 milligramme. I have, therefore come to the conclusion that with care the method I have devised on the basis of Reinsch's process for the estimation of arsenious acid in beer should allow a careful observer to estimate quantities of arsenic varying from 1-100th to 1-10th of a milligramme in 100 cc. of beer with a possible error not exceeding 1-100th of a milligramme, or about 1-6,484 grain. As one gallon weighs about 4,536 grammes, the possible error in a gallon of beer would be equal to about 46-6,484 grain, or 1-141 grain when only 100 cc. of the unconcentrated fluid are used.

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Delicacy of method.

10379. Greater accuracy is obtained when the arsenic is 1-50th, or somewhat below 1-50th, grain per gallon than when it is above that quantity, is that so?—Yes. But it is easy to reduce the proportion of arsenic estimated by diluting the fluid. In order to ascertain whether the differences we had observed would be also apparent to other not specially trained observers, I took photographs of the sublimates corresponding to 1, 3, 5, 7, 9 milligrammes of arsenic, and then explained to my laboratory steward how the sublimate tubes had to be examined to compare one sublimate with another. I then gave him sublimates corresponding to 2, 4, 6, 8, 10 milligrammes, and asked him to photograph corresponding parts in each tube without further consultation with anyone. The photographs taken by him and by myself show that a person who had never attempted to apply this analytical method could recognise differences such as I have described. Both sets of photographs have been enlarged to make comparison easier. I have also had the first set of standards photographed to the same scale, to allow comparison between fresh standards and standards preserved for six months. These photographs show that the difference between the two sets is very slight. Certain appearances of the sublimates help in the comparison of quantities, thus when the sublimate corresponds to less than 3 or 4 hundredths of a milligramme, the crystals are very small, many are imperfectly formed (star-shaped), and between them one finds a large number of small drops (possibly of amorphous arsenious acid). When the quantity of arsenious acid exceeds 5 or 6 hundredths of a milligramme, large crystals, having usually the appearance of triangular plates, occur among the small crystals.

Applicable to beer after keeping.

10380. You obtain the same results by estimations made after the material has been kept for some months?—Yes. I asked Dr. Coutts to test on the 21st May, 1901, some of the original samples of beer which we had examined in December, 1900, and January, 1901. These samples had been kept at the ordinary temperature, and had become mouldy, the decomposed beer was, therefore, thoroughly shaken, so as to distribute the fungi equally all through the fluid. As the bottles in which the samples were kept were well corked, no serious loss of arsenic could have taken place even if a volatile arsenical product had been formed. The results of the first and second sets of estimations were as follows:—Beer B (Salford).—First test: 30 to 40; second test, about 38 per ten millions. Beer C (Salford).—First test: 30 to 40; second test, about 35 per ten millions. The beer brewed in the laboratory for experimental purposes was also tested, with the following results:—Laboratory-brewed beer, first test, 130; second test, about 130 or a little less, per ten millions. An interval of about two months had elapsed between the two tests.

No evidence of cacodyl compounds in arsenical beer

10381. You have something to tell us with regard to the possible presence of organic compounds of arsenic in arsenical beer, and more especially of products belonging to the cacodyle group?—Yes. During the first few weeks of the investigation I came to the conclusion that the arsenical compounds present in arsenical beer had all the properties of arsenious acid or of arsenites, and I gave evidence to that effect before the Royal Commission in March, 1901. I have, nevertheless, made some experiments to test the accuracy of my views, and as some of these experiments were not completed when I gave my first evidence I wish now to give the results of my investigations. On the supposition that arsenic is in organic combination it may be surmised that either—

(*a.*) A loose compound is formed in the finished beer between the arsenious acid present in glucose, malt, or other brewing material, and some of the organic constituents of beer. Such a combination would be most likely to take place in the event of some insoluble precipitate being formed.

(*b.*) Some stable organo-metallic compound is produced under the influence of fermentation by the combination of arsenic with methyl, ethyl, or other alcohol radicles. In such a case one would expect some radicle belonging to the cacodyle series to be formed.

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With regard to the first supposition, I have already shown (5229) that there is no evidence of the presence of any insoluble arsenical product in arsenical beer. Arsenic is equally abundant in arsenical beer before and after filtration through porcelain.

10382. (*Professor Thorpe.*) When you speak of filtration through porcelain you mean "biscuit"?—Yes, a Chamberland bougie. I have also stated on the basis of numerous personal observations (5227) that arsenic is more easily deposited upon copper from solutions of arsenious acid in beer, than from solutions of arsenious acid in pure water. This does not show whether arsenious acid does or does not enter into some loose combination with the organic constituents of beer, but proves that if such a combination exists it does not interfere with the detection of arsenic. As this point is of some practical importance I have thought it desirable to test the accuracy of my own observations by asking Dr. Coutts to estimate the amount of arsenic recoverable from solutions of known strength, made by dissolving a definite quantity of arsenious acid in water, beer, solutions of glucose, cane sugar, and sulphuric acid (the sulphuric acid being afterwards neutralised by ammonia). The quantity of arsenious acid added was in all cases five parts by weight to 10,000,000 parts by volume of the solvent. This quantity had been found on several occasions to be easily estimated when dissolved in arsenic-free beer. The sublimates obtained from the various solutions were compared with the standard beer sublimates. The results are shown in the following table:—

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Effect of different solutions on Reinsch deposit.

Reference.	Nature of Solution.	Quantity tested.	Proportion of arsenious acid introduced in 10,000,000.	Quantity estimated per 10,000,000.
M. 86	Arsenic free finished beer	100cc	5 parts	5 parts standard sublimate.
M. 89 (a)	Pure water	100cc	5 ,,	Under 1 part.
M. 89 (b)	2 grammes glucose in 100cc water	100cc	5 ,,	Over 5 parts. **
M. 89 (c)	2 grammes of saccharose in 100cc water	100cc	5 ,,	3 parts.
M. 16 (a)	Pure water	100cc	5 ,,	1 part.
M. 16 (b)	2 grammes of glucose in 100cc water	100cc	5 ,,	Over 5 parts.**
M. 16 (c)	8 grammes of glucose in 100cc water	100cc	5 ,,	Between 6 and 7 parts.**
M. 16 (d)	2 grammes of concentrated H_2SO_4 in 100cc of water neutralised by NH_3.	100cc	5 ,,	Under 1 part.
M. 16 (e)	2 grammes of saccharose in 100cc of water	100cc	5 ,,	2 parts.

** See paragraph next below.

In the first instance, M.86, the standard was identical with standards obtained from solutions of arsenious acid in beer on previous occasions. With regard to experiments 89 (*b*), 16 (*b*), and 16 (*c*), the abundance of the precipitate obtained from the glucose solution suggested that the glucose which has been used in those experiments might not be free from arsenic as had been supposed on the basis of tests made in the early parts of the investigation. A larger quantity of glucose was therefore tested again, and it was found that it actually contained enough arsenic to account for an excess of one part in 15,000,000 of solution when two grammes of glucose were added to 100cc. of water. This accounts for the difference between the sublimates obtained from arsenical beer solution and arsenical glucose solution. The presence of glucose (2 per cent.) favours the separation of arsenic to the same extent as that of the constituents of beer does. Cane sugar also favours precipitation, but not to the same degree as glucose. In the absence of organic matter the proportion of arsenic which is separated from an arsenical solution by Reinsch's process is comparatively small. The table shows clearly that when the quantitative method which I have based on Reinsch's qualitative test is used, standards must be prepared for each kind of solution used, or else arsenic-free beer or weak solutions of arsenic-free glucose must be used as solvents or diluents. I have from the beginning adopted the latter method. This was stated in my first report to the Salford Corporation, published in January, 1901. I suspect that some of the difficulties experienced by other workers have been due to a disregard to the facts which are indicated so clearly in the above table. I think also that the same results do not favour the view that arsenious acid forms with the beer ingredients a combination tending to make its detection by Reinsch's process difficult.

With regard to the more stable organo-metallic compounds belonging to the cacodyle series, things have not proved so simple. Solutions of cacodylate of sodium in beer or in water yielded variable results when tested by the Reinsch's or Marsh's process. Sometimes a small proportion of the arsenic present seemed to be revealed, but generally speaking the portion so detected bore no definite relation to the amount of cacodylate present. Solutions of cacodylate submitted to the action of sulphurous acid or permanganate of potash gave equally unsatisfactory results when tested afterwards by either of the above methods. It therefore seemed that if cacodylate of sodium was present in beer its presence could not be certainly revealed by the direct application of the Reinsch or Marsh methods. Cacodyle oxide or some gas having a cacodyle smell was undoubtedly set free during the application of the Marsh test, but if any arseniuretted hydrogen was produced, not enough of it was usually present to yield a good deposit of arsenic in the reduction tube. Under these circumstances it seemed to me that the only *ready method* available for distinguishing between the presence of cacodylates and other arsenical products which might be present in beer must be based upon the production of cacodyle oxide and the recognition of that gas by its smell. Cacodylic acid and cacodylates are easily decomposed by phosphorous acid. Moderately concentrated solutions of these substances, extracted by appropriate processes from the urine of animals poisoned with cacodylic acid, when boiled with phosphorous acid yield white vapours which have the characteristic odour of cacodyle. The process described by Rabuteau in 1882 being rather complicated, I thought of trying whether I could not obtain cacodyle oxide directly by the use of a still more powerful reducing agent, hypophosphorous acid. I found that the addition of about an equal part of hypophosphorous acid to cacodylate solution in beer and boiling of the two fluids together was sufficient to cause an escape of cacodyle or cacodyle oxide, which could be easily detected by the smell when there was at least one part of cacodylate of sodium in 100,000 parts of fluid. Therefore, having a test for detecting the presence of cacodylate of sodium and finding afterwards it was possible to detect so small a quantity as one grain of cacodylate of sodium in a gallon of beer, I applied the same test to a number of arsenical beers, and found that no smell of cacodyle could be recognised, from which I concluded that no

Tests for cacodyl in beer.

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material amount of cacodyle compounds was present. I have not relied upon my own sense of smell to recognise whether cacodyle was present or not, but I have asked a number of my assistants who were in the laboratory, five in all, to discriminate between fluids to which cacodylate of sodium had been or had not been added, and four out of the five were able to detect at once the tubes in which cacodyle oxide was present.

10383. Could you describe the method you have devised for the rapid detection of cacodylates in weak solutions?—I take 5cc. of dilute cacodylate of sodium, add from 2 to 5cc. of H_2PO_2 solution, mix and boil for a few minutes. At the end of three or four minutes the smell of cacodyle should become distinct if there is at least 1-20th of a milligramme or more cacodyle in the 5cc. of fluid tested. The smell continues to increase in intensity for one hour or more, and is still quite distinct at the end of 24 hours and often longer. The presence of 1 grain of cacodylate of sodium in 1 gallon of beer can be detected by applying the test to 5cc. or 10cc. of beer. I tested in this way: first, many of the arsenical beers which had been sent to my laboratory; second, arsenical beer prepared in the laboratory from arsenical glucose; and, third, beer to which As_2O_3 had been added in various quantities. In no case did I obtain any smell of cacodyle. On May 30th and 31st, 1901, I tested samples of beer to which cacodylate of sodium had been added to the amount of 1 grain per gallon, and samples of ordinary arsenical beer, and I asked several of my assistants, without giving them any information as to the nature of the fluid tested, to pick out of several tubes those in which they recognised the smell of cacodyle. Dr. Coutts, Dr. Moore, Dr. Sellers, Mr. Savatard recognised the tubes containing cacodylate beer without difficulty. Mr. Finney had some difficulty in recognising the difference on one occasion, but was able to detect it on another occasion. It seems therefore probable that five persons out of six would be able to detect the presence of small quantities of cacodylates by the test which I have just described. On the ground of these tests and of the physiological experiments elsewhere recorded, I feel justified in saying that there was no material amount of cacodylates in the arsenical beer which produced the Salford outbreak.

Action of yeasts and moulds on cacodylates.

10384. (*Chairman.*) Then as regards the action of moulds of various kinds on cacodylates. You have sent us an account of some experiments which may here be taken into our notes?—Yes, they are as follows:—Yeasts and moulds grow in solutions containing various proportions of cacodylates, and these salts are decomposed rapidly by some of these organisms. The decomposition is indicated by the cacodyle smell. The smell is possibly due to the generation of cacodyle and cacodyle oxide. Now if cacodylates had been present to any extent in the arsenical beer this should have been rendered evident by the generation of the smell of cacodyle, either during the ordinary process of fermentation or afterwards, as a result of the decomposition to which beer is liable when kept in bottles which have been opened (all the samples kept for one or two weeks in bottles which had been opened, partly emptied, and recorked became mouldy). I have stated previously (Question 5232) that I have not been able to detect any cacodylate smell in any of the samples of arsenical or non-arsenical beer which have been sent to me, or which I have purchased for analytical purposes. To ascertain how far this absence of smell could be relied upon as evidence of the absence of cacodyle, I devised two series of experiments. During the month of April, with Dr. Coutts' assistance, I tested the action of yeast on wort to which pure cacodylate of sodium had been added in such proportions that the solutions contained respectively as much metallic arsenic as would have been present in a 1 per 1,000, 1 per 10,000, and a 1 per 100,000 solutions of arsenious acid. The results of some of these experiments may be summarised as follows:—

Experiment 72.—1-1,000th wort solution of cacodylate, 3 grammes of brewer's yeast added to 250 cc. of the solution. A doubtful smell of cacodyle after 12 days, and a distinct smell after 15 days. Fermentation slow. In this case unfortunately the solutions became contaminated, and the decomposition of the cacodylate of sodium seemed to be rather due to the presence of the penicillium glaucum than to the action of the saccharomyces. A very small quantity of arsenic could be revealed by Reinsch's process at any stage of this experiment, and the source of that arsenic was not certainly the cacodylate added to the wort.

Experiment 74A.—1-1,000th wort (sp. gr. 1055) solution of cacodylate treated as above. Fermentation slow, yeast fell to the bottom of vessel. After 13 days faint, doubtful smell of cacodyle. The fermentation was taking place slowly; after four days the specific gravity of the beer was 1031.

Experiment 74B.—1-10,000th wort solution of cacodylate treated as above. Fermentation brisk. Distinct smell of cacodyle after three days. After four days the specific gravity of the beer was 1021.

Experiment 74C.—1-100,000th wort solution of cacodylate treated as above. Fermentation active. After four days the specific gravity of the beer was 1018. Doubtful smell of cacodyle after three days, the same after 15 days.

Experiment 74D.—Wort without any cacodylate. Fermentation brisk, no cacodyle smell, specific gravity 1,019 after four days.

Experiment 81.—The 1-1,000th cacodylate wort of experiment 74 was divided into three parts.

(1) Left in original vessel, only a doubtful trace of cacodyle could be detected at the end of 18 days.

(2) Inoculated with sporing *Penicillium glaucum*. Three days after this inoculation the wort had a distinct smell of cacodyle; five days after inoculation the smell had become very strong.

(3) Inoculated with the white mycelium of the same *Penicillium*. Three days after inoculation smell of cacodyle distinct; five days after inoculation, smell more distinct.

From these experiments it seemed evident that cacodylate of sodium was easily decomposed by the *Penicillium glaucum*, and much more slowly by yeast, and that 1-1,000th solution of cacodylates interfered with the free growth of the yeast and mould experimented with.

In these experiments contamination by bacteria could not be prevented, brewers' yeast having purposely been used. During the months of May and June, 1901, I continued these experiments with the assistance of one of my pupils, Mr. Arthur Gill, and studied more specially the action of the *Penicillium glaucum* and *Aspergillus niger*. Pure cultures of the moulds were used to inseminate sterilised wort or sugar solution, to which various proportions of cacodylate of sodium had been added. The action of bacteria was therefore excluded, except in some cases where subsequent contaminations occurred. Careful note was taken of these cases. The results of these experiments are shortly recorded in the following summary, in which

A was the normal wort or solution of sugar.

B was the same wort or solution, to which cacodylate of sodium had been added in the proportion of 1·61 grammes of cacodylate to 100,000 cc. of wort; this solution contained about as much arsenicum as if 1 gramme of As_2O_3 had been added to the same volume.

C contained 1·61 grammes of cacodylate of sodium per 10,000 cc. (corresponding to 1 per 10,000 of As_2O_3).

D contained 1·61 grammes of cacodylate per 1,000 cc of solution (corresponding to 1 per 1,000 of As_2O_3).

I. *Wort inseminated with a few spores of* penicillium glaucum, *and kept at a temperature of* 25°C.

	Sp. gr. (19°C).	
A.	1,053·4	
4th day.—Good normal growth	1,053·5	No smell; resembling that of cacodyle.
8th day. Ditto	1,050	- ditto - - - ditto.
13th day. Ditto	1,041	- ditto - - - ditto.
After this date the growth had become contaminated owing to the repeated opening of the jar.		
	Sp. gr. (19°C).	
B.	1,053·4	
4th day.—Growth more abundant than in A	1,053	Slight cacodyle smell.
8th day. Ditto - ditto	1,043	Distinct smell.
13th day. Ditto - ditto	1,038	- ditto.
After this day growth contaminated.		
C.	1,053	
4th day.—Growth abundant; abnormal	1,050	Strong cacodyle smell
8th day.—Growth yellowish; abundant	1,046	- ditto - ditto.
13th day. Ditto - ditto Contamination	1,038	- ditto - ditto.
D.	1,053·4	
4th day.—Growth scanty; abnormal	1,050	Strong cacodyle smell.
8th day. Ditto - ditto	1,047	- ditto - ditto.
13th day. Ditto - ditto yellow	1,034	- ditto - ditto.

Although the smell of cacodyle is recorded here as having appeared only on the fourth day, I was able to distinguish it on the second and third days respectively in C and D. Mr. Gill, however, could not recognise the smell before the fourth day. In the event of fermentation being used for the purpose of detecting the presence of cacodylates there would be great differences in the results obtained by various observers, as some persons have some difficulty in analysing a mixture of smells. In these experiments the smell of the wort and of the mould obscured that of cacodyle to a variable extent.

II. *Wort inseminated with a few spores of* Aspergillus niger, *and kept at a temperature of* 25°C.

	Sp. gr. (19°C).	
A. 4th day.—Good growth; spores fewer than in C	1,051	No cacodyle smell.
8th day.—	1,047	- ditto - ditto
13th day.—	1,037·5	- ditto - ditto.
B. 4th day.—Good growth; chiefly mycelial	1,050	Slight cacodyle smell.
8th day. Ditto - ditto	1,044	- ditto - ditto.
13th day. Ditto - ditto	1,037	- ditto - ditto.
C. 4th day.—Good growth; spores abundant	1,052	Slight cacodyle smell.
8th day. Ditto - ditto	1,043	- ditto - ditto.
13th day Ditto - ditto	1,033	- ditto - ditto.
D. 4th day.—Thin, wrinkled, yellowish mycelium	1,053	Slight cacodyle smell.
8th day. Ditto - ditto	1,050	- ditto - ditto
13th day.—Contaminated with penicillium	1,045	Strong cacodyle smell.

There was the same difficulty with regard to the recognition of the smell of cacodyle, as in the case of the experiments recorded in the previous table.

Action of moulds upon cacodylates in presence of a saccharose.

In the following experiments the wort was replaced by a cane sugar solution made as follows:—

Cane sugar - - -	50 grammes.
Ammonium tartrate - -	5 grammes.
Sodium chloride - -	15 grammes.
Water - - -	2,000 cc.

This solution was distributed in jars, and quantities of cacodylate of sodium corresponding to those used in the wort experiments were added. Equal quantities of sterilised fluid were inseminated respectively with *Penicillium glaucum*, *Aspergillus niger*, and *Oidium lactis*. In the first set of experiments contaminations appeared early, the results were however in general agreement with those already recorded, I think it unnecessary to record them here. A second set of experiments yielded more satisfactory results, contamination having been successfully avoided for five or six days in every case. The results may be summarised as follows:—

1. *Penicillium glaucum*:—

A. Solution, no arsenic -	1st day - -	Growth, slight - - - -	No smell.
	2nd day - -	Good growth - - - -	—
	3rd day - -	- ditto - - - -	—
	4th day - -	- ditto - - - -	Slight, mouldy smell.
	5th day - -	- ditto - - - -	—
	6th day - -	- ditto - - - -	—
B. Solution - - -	1st day - -	Growth, slight - - - -	No smell.
	2nd day - -	Good growth - - - -	Cacodyle smell, doubtful.
	3rd day - -	Growth less than in A. - -	Cacodyle smell, distinct.
	4th day - -	- ditto - - - -	Cacodyle smell, strong.
	5th day - -	- ditto - - - -	- ditto.
	6th day - -	- ditto - - - -	- ditto.
C. Solution - - -	1st day - -	Growth, slight - - - -	No smell.
	2nd day -	Growth less than in B. - -	Cacodyle smell, distinct.
	3rd day - -	- ditto - - - -	- ditto.
	4th day - -	- ditto - - - -	Cacodyle smell, strong.
	5th day -	- ditto - - - -	- ditto.
	6th day - -	- ditto - - - -	- ditto.
D. Solution - - -	1st day - -	Growth, slight - - - -	No smell.
	2nd day - -	Growth less than in C - -	Cacodyle smell, distinct
	3rd day - -	- ditto - - -	- ditto.
	4th day - -	- ditto - - - -	Smell, doubtful
	5th day - -	- ditto - - - -	- ditto.
	6th day - -	- ditto - - -	?

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II. *Aspergillus niger*:—

A. Solution, no arsenic	1st day	Slight growth — No smell.
	2nd day	Growth increased — Mouldy smell, strong
	3rd day	Growth abundant — ditto.
	4th day	ditto — ditto.
	5th day	ditto — ditto.
	6th day	ditto — ditto.
B. Solution	1st day	Slight growth — No smell.
	2nd day	Growth more abundant — Mouldy smell.
	3rd day	Growth almost equal to A. growth — Cacodyle smell, doubtful.
	4th day	ditto — ditto — ditto.
	5th day	ditto — ditto — ditto.
	6th day	ditto — ditto — ditto.
C. Solution	1st day	Slight growth — No smell.
	2nd day	Growth more abundant — Mouldy smell.
	3rd day	Growth less than in B. — Cacodyle smell, slight.
	4th day	ditto — ditto.
	5th day	ditto — Cacodyle smell, doubtful.
	6th day	ditto — ?
D. Solution	1st day	Slight growth — No smell.
	2nd day	ditto — Mouldy smell.
	3rd day	Growth less than in C. — Cacodyle smell, slight.
	4th day	ditto — Cacodyle smell, doubtful.
	5th day	ditto — ditto.
	6th day	ditto — Cacodyle smell, slight

In these two groups of experiments, when the smell is given as doubtful, this means that Mr. Gill could not recognise it, but that I was able to distinguish it with some difficulty. Other observers sometimes were able to confirm my impression, sometimes they were not.

III. *Oidium lactis.*

The experiments with this organism were conducted as those previously recorded. They yielded negative results, except with regard to the influence which the quantity of cacodylate had upon the amount of growth, this influence was of the same nature as in the case of other organisms. The smell of cacodyle was recognised on the fifth day in the 1/10,000 solution, but this culture was contaminated by bacteria.

CONCLUSIONS.

The general outcome of all these observations may be stated as follows:—

Effect of cacodylate on yeasts &c.

1. The presence of cacodylate of sodium in a large amount (1·61 per 1,000) in wort or in sugar solution interfered materially with the growth of yeast, *Oidium lactis*, *Penicillium glaucum*, and *Aspergillus niger*. The *Penicillium glaucum* was, however, much less affected than the other organisms. The same amount of cacodylate in 10,000 parts of fluid was also usually detrimental though to a much less extent. In some cases, however, it seemed at first to stimulate vegetative activity.

The presence of the same amount of cacodylate in 100,000 parts of fluid had practically no effect upon the growth, except in the case of the *Penicillium glaucum*, which seemed for a time to thrive better in this cacodylate solution than in the normal fluid.

2. Brewers' yeast, *Penicillium glaucum* and *Aspergillus niger*, were capable of decomposing cacodylate of sodium, the presence of which was indicated by the production of a smell of cacodyle during the first few days of fermentation. The action of *Penicillium glaucum* was very much more intense than that of *Aspergillus niger* or yeast.

Cacodylate solution would evolve cacodyl on fermentation.

3. The presence of 1 grain of cacodylate of sodium in 1 gallon of beer was revealed by the production of cacodyle smell either during the ordinary fermentation of wort or during the decomposition of beer kept in bottles which had been opened and in which the fluid had become mouldy.

4. As no smell of cacodyle was detected in any of the samples of arsenical beer which I have examined, I am satisfied that none of these beers contained a material amount of cacodylate, and certainly not enough of that substance to produce any injurious effect. Direct and indirect evidence points therefore to the absence of cacodylates from the incriminated beer.

Comparison of Reinsch and Marsh estimations.

10385. Have comparisons of your results been made with those obtained by others using the Marsh method?—Some comparisons have been lately made; estimations by the Marsh test of the amount of arsenic present in beer which had been sent to me for examination in Manchester. They were made by Mr. W. Thomson, a chemist in Manchester, who found that the quantity of arsenic that he could detect in certain beers in which I had found as much as 5 parts per 10,000,000 was, according to his own estimate by the Marsh method, about 1-10th part of what I had found. The discrepancy was rather important in this case, because a case of suspected arsenical poisoning had occurred in Manchester, and Dr. Niven had asked me to examine the urine of that patient to ascertain whether it was a case of arsenical poisoning or not. I found a comparatively large amount of arsenic in the urine, something like 6 parts per 10,000,000. It was suspected that the patient might be drinking arsenical beer; some samples of beer he was accustomed to drink were sent to me, and in that beer I found 5 parts per 10,000,000 of arsenic, which corresponds to about 1-28th of a grain of arsenious acid per gallon. Two chemists, Mr. Estcourt and Mr. Thomson, thought I had over-estimated the amount of arsenic, and asked me for a duplicate sample, which I provided them with, and they found that the amount of arsenious acid was very much smaller than what I had found.

Large discrepancy in certain instances.

10386. How much smaller?—I think the amount of arsenious acid found by Mr. Thomson was something like 1-200th or 1-250th of a grain per gallon. As I have used the same test for the last 18 months, and as my first results have been entirely confirmed in almost every detail by subsequent observers, I feel some confidence in the results which I have obtained.

Experiments on rats with arsenical solutions.

10387. You have made a good deal of experimental investigation upon the action of arsenical beer and other arsenical solutions administered in large quantities to rats?—I have, and perhaps you will allow me to put the results before you in the form of a report.

(*N.B.—This report and accompanying diagrams form Appendix No.* 16.)

Effect of food taken.

10388. (*Sir William Hart-Dyke.*) With regard to these rats, I should like to ask you as to your ideas of the influence of food in the case of an animal such as a rat receiving very small portions of arsenic. Have you formed any judgment you could give the Commission as to the effect of taking food in such cases? I notice in regard to these rats that you gave them very little food?—I found that so long as I gave a large amount of food to the rats under experiment, beer to which small quantities of arsenious acid had been added, or arsenical beer such as has been drunk in Manchester and Salford, had practically no effect upon them. They continued to increase in weight, and in fact they seemed to increase in weight more rapidly than animals not taking arsenic. This occurred only when the quantities of arsenious acid were below 1-6th or 1-7th of a grain per gallon. When the quantity of arsenious acid was very considerable, the bad effects of arsenic were at once evident, even when the animals were taking a large amount of food. I found that when the amount of arsenic exceeded one grain per gallon, and when the animals took at the same time food to the extent of about 10 per cent.

of their weight per day, the animals usually increased in weight, and appeared to thrive. But when the food was reduced to 5 per cent. of their own weight, they lost weight rapidly. Now, a normal rat taking food to about 5 per cent. of its own weight would remain either stationary or scarcely decrease in weight. I found that very much smaller quantities of arsenic were dangerous when the amount of food was reduced to 3·3 per cent. of the animals' weight, which is still proportionally a large quantity of food when we consider it in relation to man. For instance, ordinary bitter beer containing only 1-143 part of a grain of arsenious acid per gallon—given to a rat in the proportion which would represent 1 gallon a day to a man, continuously for several weeks, would produce bad effects if the animal was underfed, such an animal when only given a weight of food equal to 3 or 4 per cent. of its own weight would diminish in weight much more rapidly than an animal which was given beer entirely free from arsenic. So that although that small amount of arsenic would not kill the rat, still there would be evidence that its metabolism was not satsifactory. All this is illustrated by curves of weights which I have prepared from a considerable number of data. I have here the daily records of the weights of some 20 rats which were put under experiment in this way.

10389. I should like to press you rather as to what your deduction would be with regard to human beings?—Human beings are more readily affected by arsenic than rats. I found that the amount which was necessary to produce poisoning by arsenic in rats was proportionately at least four times the dose which was supposed to be capable of producing fatal results in man.

10390. (*Professor Thorpe.*) You mean the pro rata dose?—Yes, pro rata, the percentage to body weight. In recording my observations I have reduced all quantities to a body weight percentage. For equal body weight of man and rat a dose of arsenic which would be capable of producing death in a man would be quite incapable of producing the same result in a rat. It would be necessary to give to a rat four times as much arsenic to produce death, and death even then would occur later in a rat than in a man. That is speaking generally: the lethal dose of arsenic in man is not very easy to ascertain. One is obliged to take cases which have been recorded in which death has been attributed to certain doses of arsenic. The quantities regarded as being dangerous to man vary between 1-10th of a gramme to 2 grammes, and I have taken the largest dose as being one which was almost certain to be fatal to man.

10391. (*Sir William Church.*) I think the general outcome of your experiments with these rats is really that arsenic when taken by well-fed rats was not nearly so deleterious as when taken by underfed rats?—It did not appear to be deleterious at all for a time when given in small doses to well fed rats.

10392. But when given in large doses?—When given in large doses it became deleterious.

10393. Let me point it in another way. The well-fed rat took without deleterious effects a larger amount of arsenic than the ill-fed rat?—Yes.

10394. And you also found that the arsenic was better borne and tolerated when given with beer than when an aqueous solution was given?—Yes. There was a remarkable difference between the two things. Beer apparently seemed to act as food, so that a much larger quantity of arsenic could be given dissolved in beer than dissolved in water without bad effects.

10395. That to a certain extent I think you would say holds good in man?—I am certain of it.

10396. It is generally accepted, is it not, by the profession that arsenic when given medicinally should not be given on an empty stomach, and also that the diet should not be restricted?—Yes. That was this well-known fact which led me at first to believe that the special incidence of arsenical poisoning in the outbreak at Manchester and Salford might in great part be due to the condition of the patient affected by the poisoning.

10397. Therefore you would have no hesitation in saying that the worst fed portion of the population would be more likely to suffer from arsenical beer than the better fed?—Undoubtedly.

10398. And that may be one of the explanations of what puzzled me very much when we first began this enquiry: that the workers in several breweries did not suffer. They are generally in good circumstances, and besides their beer they are well fed?—That would be the most probable explanation, and probably also the explanation why women suffered so much more than men.

10399. With regard to these experiments upon rats, the comparison of the amount of arsenic they took with their body weight does not seem to me to enable you to form any opinion with regard to what is an advantageous amount of arsenic for a man to take without prejudice to his health?—I have not found any case in which arsenic was clearly advantageous. I find that in all cases where arsenic has been given for some length of time there is evidence of its being detrimental in the end. In some cases when the rats were well fed arsenic caused a marked increase in weight, which was out of proportion to the amount of food taken. But when the animals were submitted to an alternation of high and low diet, those which were taking beer containing even a trace of arsenic suffered ultimately more than those which were taking no arsenic at all.

1-100th grain per gallon of beer not to be considered negligible.

10400. I will put it in another way. These experiments have no bearing, as far as I can make out, on what would be a negligible quantity of arsenic for human beings to take. They do not advance our knowledge on that point at all?—The only point they seem to me to show is, that a quantity amounting to 1-100th of a grain of arsenious acid per gallon would certainly not be advisable to take for a great length of time, since in all the experiments which I have made on animals which are far more resistant than man, even that small quantity seemed to produce some detrimental effects. Therefore I should say that any quantity above 1-200th of a grain of arsenic per gallon of beer would be objectionable. I cannot say whether or not a smaller quantity would be objectionable also. See Diagram 5, Experiments 18 and 19 (Period A) two rats were taken, both of which were given only 5 per cent. of their body weight of food and 10 per cent. of their body weight of bitter beer, containing only one part of arsenious acid per 10 million. You will notice that both rats while taking that comparatively small quantity of food lost weight. Then comes period B. In both cases the arsenical beer was stopped, and lager beer free from arsenic was given, and both rats on the same amount of food began to increase in weight. On the 24th day, both rats were given the first beer (containing one part of arsenious acid per 10 millions), and both of them began to lose weight again, so that the two animals behaved exactly in the same way up to period D, which begins on the 39th day. On the 39th day rat 18 was given lager beer entirely free from arsenic, and rat 19 was given bitter beer containing one part of arsenious acid per 10,000,000. You will notice that rat 18 soon after began to increase in weight considerably, but rat 19 did not increase in weight to the same extent, and after a time its weight fell rapidly. It seemed to recover for a time, and then ultimately died, very much in the same way as if it had been suffering from some exhaustive disease. That was at the end of three months.

10401. The other one seems to have lost weight nearly as much before he met with an accidental death?—No, not if you take into account the original weight of the animal. In experiment 18 the animal was gaining weight extremely rapidly.

10402. The accident then happened?—Yes.

10403. He was not killed?—No.

10404. He lost weight after the accident?—Yes. If there had been only these two experiments I would have discarded them entirely, but I have other experiments with parallel periods, the animals always losing weight when taking bitter beer containing some arsenic, and gaining weight when not taking bitter beer, the food being exactly the same.

10405. With regard to the animal losing weight when taking the arsenical bitter beer, this rate was on what I should call low diet?—Yes, but most of them were on low diet for exactly the same periods.

10406. But if it had been on full diet the arsenic might have agreed better?—It would have agreed better. But the diet was not so low as to produce detrimental effects by itself. When I found that both rats were losing weight considerably I put them on 8·5 per cent. of body weight of food. The increase in the amount of food was followed by a steady increase in weight in the animal who was not taking any arsenic, and a temporary rise in weight in the animal taking the slightly

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arsenical beer, which was followed by a gradual fall leading to death. Other experiments show exactly the same thing. For instance, in diagram 2, experiment 6, you will find that at first the animal was taking bitter beer containing one part of arsenious acid per 10,000,000 (or 1-143rd part of a grain per gallon), and 10 per cent. of its own weight of food; its weight remained almost steady. After that the beer was stopped and replaced by water, and there was a slight gain of weight. The beer was resumed on the twenty-fourth day, the amount of food remaining 10 per cent., and there was an increase of weight, though not very considerable. Then the food was reduced to 3·3 per cent., and there was a steady fall of weight, which became so marked that I stopped the beer entirely to see whether the animal would recover. He was on the point of death. The weight had been reduced to 65 per cent. of the original weight, which I found indicated a fatal result in most cases. I replaced the slightly arsenical beer by lager beer, and was able to save that rat. The rise in weight afterwards was extremely slow, although the amount of food given was sufficient.

10407. On the ninety-third day you do not seem to have increased the food very much?—I left the rat for three days on 3·3 per cent. in order to see whether the difference in the beer would produce an improvement. During those three days the animal began to recover, before I had increased the amount of food. The replacement of the bitter beer by the lager beer was followed in this case, as in all the other cases, by a distinct improvement in the state of the animal.

10408. A reduction of solid food from 10 to 3 per cent. is very great?—It is, but 3 per cent. of the body weight corresponds to 4 2-10 lbs. of dry food to a man of average weight, which is a pretty large amount of food in itself. Ten per cent. of dry food to a man of average weight would be 14lbs. a day, which is an enormous quantity.

10409. I should like to have your opinion as to whether you think these experiments in any way indicate what is a negligible quantity of arsenic for a man to take?—In my opinion they show that 1-150th part of a grain is not altogether negligible. Beyond that I would not like to go.

1-140th grain per gallon over long period detrimental to rat.

10410. (*Chairman.*) Was there any possible benefit from the arsenic to the rats?—I did not get any evidence of any permanent benefit being derived from the addition of arsenic to the drink of the animals. I got apparent benefit for periods amounting to a month or so, but I did not find that a continuous use of arsenic for more than two or three weeks or a month was beneficial. On the other hand, I had perfectly clear evidence that an amount of arsenic equivalent to 1-140th of a grain per gallon was detrimental when the amount of food was insufficient.

Tolerance of arsenic.

10411. How do you account for a human being learning to take large quantities of arsenic by gradually increasing the dose?—That is a very difficult question. It is not everybody who is capable of getting accustomed to taking large quantities of arsenic. In certain countries, Styria for instance, where the habit of arsenic eating has been common for probably a considerable length of time, no doubt some people are capable of taking considerable quantities of arsenic without any bad effect.

10412. You admit that what we so often hear of with regard to Styrian peasants eating arsenic may be accepted as true?—I think the evidence which has been collected is so complete—although some exaggeration may have crept in in some statements—that there can be no doubt that it is a common practice there for people to take arsenic.

10413. In accustoming themselves to eating arsenic do they sometimes get poisoned?—There are cases on record where people in the habit of taking arsenic in this way have suffered. I do not speak of these things from my own personal knowledge, but only from what has been recorded in literature, and therefore I would not like to insist too much on the value of my statements, although as far as I am concerned I believe them to be correct.

Question of negligible daily dose of arsenic.

10414. Might 1-100th grain per day be distinctly injurious to a human being?—That is my own conviction.

10415. Would 1 grain per day be unmistakably poisonous?—**Yes**; it would give rise to acute poisoning in most people—not in everybody. There are some people who might have acquired tolerance after taking the drug for a time. There is no drug the action of which is so uncertain as arsenic. Some people cannot bear the slightest trace of arsenic administered by the mouth. Even if used for the purpose of killing the pulp of teeth, arsenic may produce such intense nerve irritation that some people are not able to bear its action. Other people, on the contrary, are apparently capable of bearing large doses of arsenic taken by the mouth.

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10416. 1-10th of a grain per day would be liable to produce serious results on human beings?—Yes, within a very short time. I am perfectly satisfied now that even 1-100th of a grain would not be safe, or, at any rate, that nothing above 1-100th of a grain would be safe to take as a daily dose for a considerable length of time.

10417. (*Dr. Whitelegge.*) You say that the variation of susceptibility is greater in relation to arsenic than to most other drugs in man?—I may have put the statement too strongly; it is one of the drugs in which idiosyncrasy is of extraordinary importance.

Susceptibility of rats to arsenic.

10418. Would you extend that proposition to the rat?—I have no means of judging. I saw only one case in which I thought the rat was unusually quickly affected out of a series of 22 that I experimented upon. The rat to which I refer is the rat in experiment 7, in which I found that the presence of 10 per cent. of alcohol added to 1-7th of a grain per gallon of arsenious acid beer produced death extremely rapidly. That appeared not to be entirely explained by the addition of the alcohol, which seemed to have very little effect on the other rats.

10419. Were the rats all growing?—They were all rats which had not quite reached their full size, but they were nearly adults. They generally weighed above 150 grammes. The largest rats I had at the time weighed 200 grammes. I tried experiments on young rats, but I could not manage them. They would not take their food during the administration of arsenic well. Two young rats which I experimented upon died so rapidly that I did not venture to make more experiments of that kind for the time.

Evidence of peripheral neuritis in arsenicated rats indefinite.

10420. Is it possible to say anything with regard to peripheral neuritis in connection with rats?—I found no clear evidence of these rats suffering from peripheral neuritis during life. They did not show any signs of unsteadiness of gait; they could stand on their hind legs quite well in the usual way, take hold of things with the front paws as normal rats do, and they could wash their faces. There was no sign whatever of paralysis. They had no loss of power over their limbs. In no case did I see any evidence of there being any difficulty in the performance of any of their movements. They took water with their paws very much like a human being, sucked their knuckles, and they had perfect control over their limbs. They sometimes looked drowsy, and were difficult to rouse, as was noticed in the case of patients suffering from arsenical poisoning. After death I could not find any clear evidence of the nerves being in a state of neuritis. In two or three cases the nerves were not quite normal. On the other hand, one of my pupils working at the central nervous organs found a large number of nerve cells in a state of more or less advanced degeneration, and this would account for the drowsy condition.*

10421. (*Sir William Church.*) Were those nerve cells in the spinal cord or in the brain?—Both. A certain proportion of the nerve cells were affected both in the brain and spinal cord. The degeneration was marked by breaking up the chromatophile elements. I have some photographs here of those nerve cells in various states of degeneration (*photographs put in*).

10422. (*Dr. Whitelegge.*) It would be quite possible if the observations were continued longer with smaller doses of arsenic that something like peripheral neuritis might make its appearance?—Possibly, but I do not think there is much post-mortem evidence of unmistakable peripheral neuritis even in the human subject, that is to say, as a primary lesion. In the brains and spinal cords of patients dying from so-called peripheral neuritis which we have examined in the laboratory, it has seemed to me that the changes in the central nervous system were far more marked than those in the

* As to this reply, however, *see* observations made in Appendix 16, on p. 191, below.

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peripheral nervous system. Of course the peripheral nervous system is bound to be affected after a time if the central nervous system is affected.

10423. With regard to accumulation, in your summary you say "When arsenic is administered in large doses there seems to be no accumulation"?—I have not put the sentence there quite correctly. I should have said there seems to be accumulation. What I have found is that when a very small amount of arsenic is administered daily there seems to be an accumulation. There is an accumulation, because one finds several days after the arsenic has been stopped that there may be in the body a larger amount of arsenic than the daily dose given. If one gives a very large dose of arsenic, the amount found in the tissues is always smaller than the amount given daily.

10424. Would you put it this way, that the absolute amount stored up in the body may be greater with the small doses than with the large doses?—No; what I want to say is that the body is apparently capable of storing up for a time a certain amount of arsenic. If small doses are given successively these may cumulate until the storage limit is reached. If, on the contrary, doses exceeding the maximum that can be stored up in the body are given, elimination of the excess apparently takes place rapidly, so that the amount of arsenic retained may be less than the amount given in a single dose.

10425. (*Chairman.*) In one case you mentioned a very large discrepancy between the quantitative estimate that Mr. Thomson made and your own result. I think you said Mr. William Thomson found 1-200th of a grain, and you found 1-30th of a grain?—Yes, about.

10426. Did you get any explanation of that discrepancy?—I could not find any explanation of the discrepancy. I supplied Mr. Thomson with the sample of beer, which I had tested myself. He wanted to try it, and he gave me his own estimate. He used Marsh's test, and I used Reinsch's test. That is the only difference. I mentioned this case because I was asked whether I was aware of any discrepancy between my results and those of other observers. This is the most striking discrepancy I am acquainted with.

10427. Have you had other cases in which there was a satisfactory and fair agreement between your test by the Reinsch methods and other tests by the Marsh method?—Generally speaking there has been a marked discrepancy from the first. Quite in the early part of the investigation in 1900-1 the estimates made in Manchester by chemists using Marsh's method often showed no arsenic whatever when I found a good deal by Reinsch's test. Later on, even during the months of January and February, 1901, after a period of experimentation, the results obtained by myself were generally higher than those obtained by chemists who were using Marsh's method. It is only lately that the same specimens happened to have been examined within my knowledge by a chemist whose experiences can be certainly relied upon. Mr. Thomson is a man in whom we have all confidence in Manchester, and I cannot account for the difference of results.

10428. Are you forced to the conclusion that the Marsh test is dangerous in not finding arsenic when the Reinsch method will find it?—I would not go as far as that. It is a matter of accident sometimes when the test does not give the same results. I would not venture to criticise the Marsh test, because I am not an expert chemist, but in my hands it has not yielded as good results as the Reinsch's test.

10429. Yet you have found very large discrepancies not confined to this single instance?—In the early part of the investigations there were very great discrepancies. Several analysts could not find any arsenic, or nothing more than traces of arsenic, when Dr. Coutts and myself were able to find by Reinsch's process material quantities of arsenic. At that time I think facts proved that I was correct in my estimations and conclusions.

10430. It was proved that you were right by independent tests?—Yes.

10431. By the Marsh tests?—Partly, and partly by the precipitation of sulphide. Professor Campbell Brown, of Liverpool, found very much the same quantities of arsenic by precipitation of sulphide, sometimes more than I have found, either in the same samples or in samples obtained from the same source. Professor Dixon in Manchester, also by precipitation of arsenic as sulphide, found very nearly the same quantities.

10432. He found it by the sulphide itself?—Yes.

10433. It is a very serious matter if it should turn out that one test should give seven times as much as another?—Yes. That discrepancy has existed before.

10434. And it is still the same?—Yes, and it will go on I think so long as different methods of applying each test are used.

10435. There can be no doubt that when the Marsh test is applied to a solution from which a previously measured quantity of arsenic has been taken out, and the liquor again tested, nothing is found. There seems to be no room for error there?—I think there is room for considerable error. First of all, you have to break up the organic matter, and that is not such an easy process as is generally supposed. Secondly, you have to prove that you have entirely reduced the arseniuretted hydrogen as it passes through the reduction tube. If some part escapes, of course you lose a portion of the arsenic, however completely arsenic may have been removed from the original substance.

10436. But we have heard that 1-200th put in expressly could be detected by the Marsh method. The test is repeated on the liquor which shows nothing, therefore the test has taken all the arsenic out?—Yes, but has the arsenic in the reduction tube been weighed?

10437. (*Professor Thorpe.*) The thing has been proved in another way. It was admitted to us in evidence by Dr. Luff that a solution of arsenious oxide, which was insensitive to the further action of copper, which would not give a Reinsch reaction, would nevertheless give a Marsh mirror?—I have done the same thing myself at the very beginning of my investigations, and have already explained that the accuracy of the Reinsch's process and of my quantitative method are not based on the complete precipitation of arsenic.

10438. We had it also in evidence from Mr. Hebner that he could not rely upon the Reinsch to a greater degree of sensitiveness than 1/50th of a grain. He thought that was its limit of delicacy. But he did not attach any definite limits in the case of the Marsh test. Both he and Mr. Chapman said there was no difficulty in picking up 1/200th of a grain?—There is no difficulty in picking up 1/200th of a grain by Reinsch's—you can even pick up 1/500ths of a grain quite easily. But I do not advocate Reinsch's test because it is an absolutely perfect test; on the contrary, I quite grant it has great limitations, but these limitations are not more detrimental than those of the Marsh test. I have proved from the first that by Reinsch's process as usually applied only a portion of the arsenic present in the solution tested is precipitated. From the same fluid a precipitate of arsenic may be obtained in succession upon a great number of pieces of copper. Therefore I do not attach any importance to the entire precipitation of arsenic. My point is that if you place a certain quantity of beer in presence of hydrochloric acid and of a definite quantity of copper in a vessel of a definite capacity, under exactly the same conditions of heat, for a certain length of time, you can recover in that time a quantity of arsenic which is proportional to the whole amount of arsenic present, provided the amount of arsenic is not too large. I have used a very limited quantity of unconcentrated beer, and thus have purposely limited the delicacy of the test. If I wanted to obtain a more delicate test I should use four times as much beer. I might also reduce it by evaporation, and increase the delicacy of the test.

10439. (*Professor Thorpe.*) That could be done by any method?—(*Re-written answer.*) Yes; but I claim that by the method I use I can, *without concentrating the beer*, detect as small a quantity of arsenic as can be detected by the Marsh process after somewhat complicated operations. I have purposely limited the delicacy of the Reinsch's process by using only 100cc. of beer for my preliminary test, because I found that with this standard quantity of beer it was easy to detect and estimate 1-143rd grain of arsenious acid in 1 gallon of beer. It is therefore obvious that I could detect and estimate a very much smaller amount of arsenic by using a larger amount of beer. This I have already stated in my previous evidence. I wish also to point out that out of the two pieces of copper employed for each test, I sublimate one only. No doubt that by using special precautions the Marsh test can yield very good results, but, so far, I have not found that the results obtained by it were more satisfactory than my own. There is, however, one thing which seems to me difficult to under-

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stand, and that is the difference between the results obtained by Marsh's method and by Reinsch's process in the case to which I have previously alluded (10425). If the method I use is much less delicate than the Marsh's, how is it that I have been able to obtain from a sample of beer seven times as much arsenic as an expert chemist could by an improved Marsh process? If from a beer containing 1-200th grain of arsenious acid per gallon, according to the chemist, I can obtain repeatedly a sublimate which is five times more abundant than my smallest standard sublimate (which does not even indicate the lowest limit I can reach), it follows that by my method I *should be able to detect easily* 1-1000*th grain of arsenious acid per gallon;* and as by my method only 100cc. of beer are sufficient to obtain a sublimate, the *actual quantity* of arsenic revealed by that method would on that supposition be 1-45000th of a grain, which is an absurdity. I am therefore led to believe that in the case in question the whole of the arsenic present in the beer was not *revealed* by the Marsh process, however completely it may have been *removed* from the material tested.

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TWENTY-FIFTH DAY.

Friday, 20th June, 1902.

AT WESTMINSTER PALACE HOTEL.

PRESENT:

The Right Hon. Lord KELVIN (*Chairman*).

The Right Hon. Sir WILLIAM HART-DYKE.
Sir WILLIAM CHURCH.
Professor THORPE.
Dr. WHITELEGGE.

Dr. BUCHANAN, *Secretary.*

Mr. A. R. Ling. 20 June 1902.

Mr. ARTHUR R. LING, called; and Examined.

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10440. Mr. B. E. R. Newlands and yourself have some evidence to give us regarding the presence of arsenic in fuel, and the mode of the treatment of fuel in respect of arsenic?—Yes.

10441. I believe Mr. Newlands is a past vice-president of the Institute of Chemistry and of the Society of Chemical Industry, and member of the Society of Public Analysts, etc.?—Yes.

10442. And you yourself are a Fellow of the Institute of Chemistry, member of the Society of Public Analysts, hon. local secretary of the London Section of the Society of Chemical Industry, and editor of the journal of the Federated Institute of Brewing?—I am.

10443. I believe both you and Mr. Newlands practise as analytical and consulting chemists in the City of London?—We do.

10444. Do you work together?—Yes, to a large extent in connection with brewing, especially myself.

10445. You have had a large experience with malting fuel?—Yes.

Arsenic in Malting fuel

10446. Have you ever, in that experience, met with a sample free from arsenic?—I can say confidently I have never met with a sample free from arsenic in the course of a very large experience with malting fuel.

10447. Never?—Never.

10448. Even a fuel expressly provided for malting?—No other fuel is referred to in this evidence except fuel obtained from maltings.

10449. And fuel such as has been used since the warning which was given a year ago?—Yes.

invariably present.

10450. Do you find that since the warning given a year ago the fuel that is used is still not free from arsenic?—I have never met with a fuel of any kind whatever free from arsenic.

Method of determining arsenic in fuel.

10451. How do you determine arsenic in fuel?—The method of determining arsenic in fuel is one which was described by Mr. Newlands and myself in a conjoint paper read before the Institute of Brewing on June 11th, 1901. It consists in burning a portion of the fuel and estimating the arsenic in the ash by the Marsh-Berzelius method, and in burning a second portion of the fuel mixed with a proportion of a base, such as lime, soda, or magnesia, and estimating the arsenic in the ash from that. The second determination gives the total arsenic, the first determination giving the arsenic fixed by the ash. The difference between the two gives the volatile arsenic.

10452. The second will be the sum of the two?—The difference between the total arsenic and the fixed arsenic will give the volatile arsenic.

fixed, and volatile.

10453. Do you consider that the second process gives the whole arsenic?—The second process gives the whole arsenic, as I have proved by numerous experiments with fuels and other organic substances, such as sugars and yeast, to which known quantities of arsenic have been added, and which have then been burnt in the same manner and the arsenic estimated.

10454. Do you consider that would be a good plan for finding the total arsenic in worts or in beer—to dry it and then burn it with an added base?—I do, I consider it a very good process indeed; in fact, it is one that the joint committee of the Society of Chemical Industry and of Public Analysts suggested as an alternative in cases in which destruction of the organic matter was necessary. They gave two processes, one the destruction of organic matter with nitric and sulphuric acid, and the other the burning with a base, as you have suggested.

10455. The Marsh-Berzelius method would be a simpler process for beer?—In the cases you refer to, the final test would be the Marsh-Berzelius method.

10456. The Marsh-Berzelius applied direct to the liquor suffices for most cases?—In my experience I have found that in the case of beer it gives reliable results when directly applied.

10457. So that the combustion method, although it would succeed, would be more elaborate but not more sure?—In my experience it is not necessary, but I am aware that some have contended that the arsenic is sometimes present in beer in a form in which it does not respond to the Marsh-Berzelius test. That has not been my experience. I ought to have said that I used hydrochloric acid when I worked with the direct Marsh test in beer. I believe that when sulphuric acid is used it is impossible to apply the Marsh test direct to beer with satisfactory results.

10458. I believe that Mr. Newlands has taken out a patent in connection with the process you have described, for the treatment of fuel with a base?—He has.

10459. Not a process for testing fuel?—Not for the purpose of testing fuel, but for the purpose of retaining the whole of the arsenic in the fixed condition in malting fuel.

10460. The object then is to burn the fuel by this method in the malting kiln?—Yes.

10461. Dr. McGowan has suggested some questions which we might put to you with reference to what you have told us. Have you definitely proved that the whole of the arsenic in fuel is retained by ignition with, say, sodium carbonate?—Yes, with any base such as lime, magnesia or sodium carbonate provided that the mixture be sufficiently intimate. Not only I, but several others have proved the same thing.

10462. I suppose you tried two cases—sodium carbonate in one case, and lime, ordinary quicklime, in the other?—Yes.

10463. Did the results agree in those two cases?—Yes.

10464. In the tables which you have handed in, the total arsenic determined in anthracite is, in some cases, equal in amount to the volatile arsenic determined?—Yes.

10465. May not this possibly indicate that some of the total arsenic has escaped estimation?—If that were so I cannot think that it was due to the arsenic not being retained by the base. It may be due to something we do not know of at the present time, some influence of certain substances on the Marsh-Berzelius method, but I am convinced that it is not to be ascribed to any fault in the non-retention of a portion of the arsenic by the base; because in the results I have brought forward I have always taken special care to intimately mix the fuel with a sufficiency of the base, and not only so, but, as I stated before, I have proved absolutely that when known quantities of arsenic are mixed with an organic substance and with a base and burnt the whole of the arsenic is retained.

10466. Must the fuel be very finely broken up for this process?—Yes; for the analytical process the finer the fuel is broken up the better. The more intimate will the admixture be. I should certainly advise that. My plan is to grind the sample for analysis in an agate mortar, and very often sift it.

10467. That would be too fine a powder to work in the malt kilns?—Just so. The only thing one can do on the technical scale is to coat the fuel with a base, such as lime wash, or to absorb a portion of solution of soda ash. One cannot expect to treat fuel with a large excess of a base such as you would in laboratory determinations.

10468. Have any experiments been made to prove that the fuel can be so treated with lime on a practical scale as to give no arsenic in the fumes when it is burnt in the kiln?—I have a large number of analyses here proving that malt dried with fuels so treated contains only negligable quantities of arsenic—generally 1-1000th of a grain per lb., or below.

10469. To return to the method of testing: what volume of liquid do you employ in the Marsh-Berzelius apparatus?—The volume of liquid employed is the same as that indicated in the report of the conjoint committee of the Society of Public Analysts and of Chemical Industry. I was one of the committee, and the method I adopt is in all cases the committee method.

10470. Does the volume used appreciably affect the depth of the mirror obtained?—I believe it does. But most of my experiments have been made with the size of flask recommended in the committee's report, and I have really very little experience except in the early days of the arsenic scare to prove that.

10471. You believe that not quite the same mirror would be obtained with a certain quantity of arsenic and 30 cubic centimetres of liquid as you would get with the same quantity of arsenic and 50 cubic centimetres of liquid?—I believe that would be the case.

10472. The mirror would be different?—I believe it would. I regard the quantitative Berzelius-Marsh test as a purely empirical one. Whatever apparatus I was working with I should make my set of standard mirrors for that apparatus, and then it would have no effect whatever upon the quantitative results, provided I used the mirrors obtained with the same apparatus that I was working in the actual analyses.

10473. So that if you were going to use 50 cubic centimetres of liquid in your test you would make your standards from the known quantity of arsenic put into the 50 cubic centimetres?—Yes, exactly.

10474. Would it be necessary to vary the amounts of lime used in the ignition for estimation of the total arsenic in the case of, say, 1 gramme or 10 grammes of fuel?—I should say decidedly yes, because in all cases an excess is employed. If I used ten times the amount of fuel I should use generally ten times the amount of base. Quantity of lime added in determining "total arsenic."

10475. What weight of base do you consider proper in proportion to the fuel?—I think, provided the mixture is intimate, 10 grammes of fuel require only 1 gramme of base. That is quite a sufficient excess—that is a very large excess indeed.

10476. (*Sir William Hart-Dyke.*) You use it *pro rata* according to the quantity?—Yes. I believe the amount recommended in the report of the joint committee is equal portions of a base and fuel. That is more than I employ; in fact, it is more than is necessary.

10477. (*Chairman.*) In the furnaces of the malt kilns the proportion of weight of lime to weight of fuel must be very small?—Very small indeed; in fact, 5 per cent. is the most we have experimented with; 5 per cent. of lime added in the form of a wash is found to be ample. Addition of lime to fuel on kiln.

10478. Is that found quite sufficient to keep down all the arsenic?—Yes; provided, of course, that the fuels be not too arsenical. I have no experience with highly arsenical fuels, because I have not gone out of my way to get such fuels. I have simply analysed those fuels which came from maltsters. Although I have met with very bad samples of anthracite, I have had no fuels of the highly arsenical nature such as I have seen in published analyses—gas cokes, for instance. I do not know what would happen if one employed such highly arsenical fuels. Then, I take it, one would have to use more base.

10479. On extracting the ignited residue of ash and base with acid, may not some of the arsenic be in an insoluble form, such as sulphide?—That certainly is a point which occurred to me. As a matter of fact it is so. When one dissolves the ash of a coke, say in hydrochloric acid, a large volume of sulphuretted hydrogen is always evolved; but it must be remembered that even if sulphide of arsenic were formed I know from my own experience that it responds to the Marsh test as easily as arsenious oxide does, possibly because we are dealing with so large a dilution that the sulphide is in that dilution a soluble compound. I believe it to be. Extraction of ignited residue.

10480. You do not feel quite sure, but it is possible that some of the arsenic may be converted to an insoluble form, such as sulphide, and be removed from the sphere of action of the Marsh test?—I think very likely some of it may exist as sulphide, but that will not be removed from the sphere of action because it will respond to the Marsh test. I do not admit that in the dilutions that we employ in the Marsh test arsenious sulphide is an insoluble compound; I believe it to be a soluble compound. I am speaking from memory, but I believe the solubility is something like one part in 7,000,000, and we have usually a much greater dilution than that. Solubility of sulphide of arsenic formed.

10481. Do you think it would be an improvement if the residue of your combustion was oxidised?—That is my practice at the present time. At first my results were obtained by heating the residue with an excess of hydrochloric acid at about 70deg. C. for a short time, allowing it to remain for about 12 hours, making up the volume, or using it direct as the case might be, introducing it into the Marsh apparatus on the following day. The method I have adopted recently is to heat with hydrochloric acid and a few drops of nitric acid until the whole of the sulphuretted hydrogen is destroyed. I heat it for a long time in that way, and allow it to stand for a number of hours. Before introducing it into the Marsh apparatus I add a little sulphurous acid to destroy any nitric acid present. I also have used bromine as an oxidising agent in the case of the residues of some cokes. Residue is now oxidised.

10482. Is bromine an oxidising agent?—Yes.

10483. How does bromine act as an oxidiser—where does the oxygen come from if you use bromine?—Bromine acts as an oxidiser in becoming converted into hydrobromic acid; it combines with the hydrogen from the water and thus liberates an atom of oxygen.

10484. After moistening your residue with nitric acid or otherwise treating it as you have described to oxidise it, do you evaporate it to dryness and re-ignite it?—No, I do not.

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10485. Do you take it in its moist state and put it into the Marsh apparatus?—Yes, I should consider it dangerous to evaporate in the case of small quantities of arsenic, because when the whole of the nitric acid is removed I believe that the hydrochloric acid might possibly act as a reducing agent, and volatilise a portion of the arsenic as chloride, especially in the presence of iron, because we have a well-known analytical process of determining arsenic by distilling with hydrochloric acid in the presence of iron salt.

Iron salts impairing Marsh estimations.

10486. Does the presence of, say, 1-10th of a grain of ferric iron in the Marsh apparatus prevent the formation of a mirror of quantitative accuracy?—I have no experience, or very little experience, of the addition of iron salts to the Marsh apparatus, but I have experience in the granulation of zinc with a salt of iron, in which it was found to considerably impair the sensitiveness of the zinc. By sensitiveness I mean the depth of the mirror formed with a known amount of arsenic. Some time ago I endeavoured to remove arsenic from arsenical zinc by various means, and one idea which suggested itself to me was to fuse the zinc, or endeavour to fuse it, with metallic chlorides, and among the metallic chlorides I chose for this purpose was ferric chloride. The method, I may say, was not successful. The zinc which I obtained contained a trace of iron, and it was so very insensitive that it would not show in the Marsh apparatus a mirror when 1-100th of a milligramme of arsenious oxide was introduced, whereas ordinary pure zinc free from arsenic—pure zinc—will show 1-1,000th of a milligramme.

10487. 1-1,000th of a milligramme in what quantity?—In the Marsh apparatus as recommended by the committee, say 100cc. of liquid.

10488. Does your answer apply equally to ferrous iron and ferric iron?—I am afraid I cannot give the Commission any evidence on the systematic addition of either ferrous iron or ferric iron to the Marsh apparatus; I cannot supplement what I have said in regard to iron in any way. I know it has been stated that the presence of a slight amount of iron in the zinc tends to increase the mirror; we have a statement in our report by Mr. Allen, of Sheffield, to that effect, but I have no evidence on that point.

10489. (*Professor Thorpe.*) May I point out that apparently there is a contradiction in terms—the iron in the Marsh apparatus is ferrous iron?—It must be ferrous iron, only of course the reduction of ferric iron which is in the insoluble state of ferric oxide, provided you have not dissolved it all up, may be a slow process, though there is an error involved in that in the first place, because you ought to dissolve it all up.

Unequal distribution of arsenic in anthracite.

10490. (*Chairman.*) Do you find that as regards arsenic different samples of anthracite are uniform?—I find that anthracite is anything but uniform. I believe that to present a great difficulty. One of the greatest difficulties met with in the analysis of anthracite *qua* arsenic is to obtain a uniform sample of a given bulk.

10491. Do you find it possible to obtain a representative sample of Welsh anthracite?—I find it possible to obtain fairly representative samples, but I have some figures which I can give the Commission illustrating the selection, or the attempt at selection, of average samples from the same bulk. Three samples, each of which may be described as average samples, were taken from the same bulk. No. 1 gave 1-30th of a grain of volatile arsenic per lb., and 1-333rd of a grain of fixed arsenic. No. 2 gave 1-50th of a grain of volatile arsenic per lb., and 1-50th of a grain of fixed arsenic. No. 3 gave 1-33rd of a grain of volatile arsenic per lb., and 1-33rd of a grain of fixed arsenic. From these samples some pieces containing slate were selected which contained very much larger quantities of arsenic; for instance, $\frac{1}{4}$th of a grain of volatile arsenic per lb. and $\frac{1}{5}$th of a grain of fixed arsenic. Perhaps I may show you these two samples, one of which is an average sample of the fuel used. You will see, if you look at the bad sample, that there are veins of slate running through it.

Arsenic in samples where no visible pyrites.

10492. I see no signs of pyrites?—There are none apparently; I have not observed any.

10493. If you chose a pyritic sample, the quantity of arsenic would be considerably greater?—I believe the chief source of arsenic in all coal is pyrites.

10494. And yet in these there are no pyrites to be seen?—I have also stated in my précis that slate is also a source of arsenic.

and in slaty specimens.

10495. (*Professor Thorpe.*) Do you mean that the slate *per se* is arsenical, or that pyrites is associated with the slate?—I cannot say that. I find that slate in all cases, isolated from anthracite, contains arsenic. I have one case here in which 1¾ grains per lb. of total arsenic were found in the slate.

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10496. In the slate?—Yes.

10497. You have no evidence as to the form of combination?—No, I have not examined it under the microscope.

Arsenic in pyrites from anthracite.

10498. (*Chairman.*) Have you tested pyrites, what we used to call slate diamond, and what percentage of arsenic did it contain?—I have tested for the purpose of this evidence several pieces of pyrites obtained from Welsh anthracite, and they contained the least arsenic of any pyrites I have examined. I have a piece here, for instance, in which I found 10 grains per lb. of arsenic. In other samples I have found less, for example, 7 grains of arsenic per lb.

10499. Have you sometimes found large pieces of pyrites embedded in the anthracite, such as slate diamond?—I have done.

10500. But you have not tested such a specimen by itself to see what proportion of pure pyrites it contains?—No; I should say that such a specimen as that would contain 90 per cent., or even more, of the pyrites.

10501. And that containing 10 grains per lb. gives you an idea of how much the pyrites itself contains?—Yes. Pyrites, I ought to say, from other coal contains very much larger quantities of arsenic than that, but from anthracite coal I have not found more, although I believe others have done so.

Presence of pyrites can not always be judged appearance

10502. Does pyrites occur in veins and sometimes in the middle of pieces of coal?—That is so, but I do not think the latter is often the case.

10503. Is it always possible to detect the presence of pyrites by the external appearance of the coal?—Certainly not. It is not always possible to detect arsenical contamination from the external appearance of the coal.

10504. The specimen that contains a quarter of a grain per pound of volatile arsenic and one-eighth of a grain of fixed arsenic shows no external signs of pyrites? It shows no external signs of pyrites, but it does show signs of the presence of slate, and such a specimen as that I should regard with the greatest suspicion.

10505. If these pieces were broken up much smaller, would pyrites be visible?—I have not found it visible.

10506. It may be so finely mixed with the anthracite as not to be perceptible to the naked eye?—I cannot say whether that sample contains pyrites or not. Its arsenic may be derived from pyrites, but I have no proof that it is.

10507. (*Professor Thorpe.*) Have no petrographic analyses of these materials been made in the same way that geologists make analyses, by slicing them up and looking at them through the microscope?—It is quite possible, I should imagine, to detect the minerals in a thin section by means of the polarising microscope.

10508. Have not you or the other analysts who have been working in this matter done that?—I am afraid that so many things have arisen on this question that we have not had time to do so; I can find no record of mineralogists having done such a thing. I quite agree that it should be done.

Pyrites in anthracite

10509. (*Chairman.*) The chief source of arsenic in all coal is the pyrites or coal brasses?—Yes.

10510. Are these pyrites chiefly iron sulphide, or are they also copper sulphide?—I have found no copper whatever in coal brasses, although I believe the presence of copper is occasionally recorded in analyses of coal brasses.

10511. May pyrites occur not as brasses but as black pyrites mingled with the coal?—Certainly it may.

10512. Do you think it is probable that such black pyrites may form a very fine mechanical mixture?—That I believe to be the case.

10513. When pyrites occurs in high grade anthracite containing but little ash, is the greater portion of the arsenic volatilised on burning the anthracite?—That would be the case.

10514. Would it be the case if the anthracite had previously been treated with a base?—No. Provided a sufficiency of the base were used. If 5 per cent. of the base were used in practice, practically the whole could be kept back.

10515. You tell us that the presence of coal brasses in anthracite has been long known, and that at one time it was regarded as one of the advantages of this fuel from a malting point of view?—That is so, on account of the sulphur it contained. The sulphur rises and comes into contact with the malt, and bleaches it to a certain extent, and those maltsters who liked pale malts attached importance to the presence of pyrites in the old days on that account. I have an extract dealing with the subject from an old book, called the "London and Country Brewer," published in the eighteenth century. The author there speaks of a certain brand of anthracite coal in which pyrites is found, which is distinctly favourable to the producton of pale malts by reason, he says, of the sulphur it contains. In fact, so much sulphur does it contain that he states it was impossible to remain in a room in which it was being burnt.

10516. I have a distinct recollection of going through a malt kiln just a year ago in which anthracite, supposed to be of the very best quality for malting, was used, but I remember noticing on the floors a very decidedly pungent odour; was that sulphur?—Probably it was sulphur, but I could not say.

10517. That itself seems to prove that there must have been pyrites?—Yes.

10518. The charcoal could not have given anything like a pungent smell?—No, it could not.

10519. In walking over a malt floor during the process, is a pungent smell generally noticeable?—In cases in which the very best selected anthracites are used there certainly is not any noticeable odour, not as a rule.

10520. But hitherto that has been regarded as anything but an evil?—Yes, because, as I have explained, the sulphur bleaches the malt, and maltsters like to have as pale a malt as possible, other things being equal, and also want to please the eye of their customers.

10521. There was no suspicion of arsenic in connection with the material that gave that bleaching property?—In the old days, no. No one had any idea before the arsenic scare that malt contained arsenic, or was liable to contain arsenic.

10522. I see it is stated in the "London and Country Brewer" that no malting fuel "is so much in esteem as the golden streaked coal of Tenby, which is endowed with so much sulphur that in the ships that come from thence they can hardly bear the room it is burnt in, and at Bristol is sold for 8*d.* a bushel, where they are in no small concern for this sort of coal, because its great usefulness has of late encouraged them to dig so much out that their mines at this place are almost exhausted." Is it on record that there were any illnesses from drinking beer in those days?—I am not aware of any.

10523. But a good many people who consumed two or three gallons of beer a week may have been poisoned in virtue of that coal which was in so much request?—They may have been so.

10524. You have spoken of the difficulty of obtaining a representative sample of anthracite. Is that an argument against the possibility of accurately selecting samples sufficiently free from arsenic for malting purposes?—I think it is a strong argument against it; I would go further than that and say that even if it were possible to select a sample for analysis it would not be possible to ensure that the maltster every day of his work is making use of an average sample. As I have already stated, anthracite is so very variable in its composition, that one day he may be making use of a sample containing very much more than he was using another day, so that the analysis of an average sample would not help entirely, although it would be helpful.

10525. Even if a maltster's average anthracite was sufficiently free from arsenic he could not be sure that on some dates some tons would be used which would contain a dangerous amount of arsenic?—I would not go so far as to say dangerous, because I do not know what that means, but I would say that he could not ensure that his malts would not vary in the amount of arsenic they contained; he could not be sure that he was making use every day of an average sample.

Less arsenic lately in malting anthracite.

10526. Has attention to fuel in your experience done much to reduce the amount of arsenic in malt?—I think it has; in fact I am sure it has. When I first commenced to examine fuels for arsenic by the method I have described to you, in April or May of last year, one met with anthracite containing certainly larger quantities of arsenic than one does at the present time.

10527. In the early part of 1901 did you meet with samples of malt containing 1-50th to 1-25th of a grain per pound?—That is so. Those samples were obtained from the maltsters, and it is probable they were all coke dried.

10528 (*Sir William Hart-Dyke.*) Gas coke?—Probably gas coke.

10529. (*Chairman.*) Do you mean that anthracite had been used in the malting and gas coke in drying the malt?—No, I mean that in the samples containing these very large quantities of arsenic, coke had been used throughout for drying; but that was in the early days of the arsenic inquiry.

10530. At the present time what amount of arsenic may be frequently found in malt?—In malts dried with anthracite or said to be dried with anthracite, we seldom find more than 1-300th of a grain per pound. I should say that in samples which come to us without our knowing how they have been treated it is rare to find more than 1-150th of a grain of arsenic per pound of malt.

Calculated amount of arsenic in anthracite which may reach malt.

10531. With selected anthracite containing 1-25th of a grain of volatile arsenic per pound, you account for as much as 1-150th of a grain per pound in the malt?—There is a possibility of the malt containing as much as that, assuming the whole of the volatile arsenic reached it, but this is simply a calculation.

10532. If a portion of the volatile arsenic was fixed, by lime for instance, then it could not give as much as 1-150th of a grain per pound of malt?—It would not, in my experience.

Analysis of fuel.

10533. Is chemical analysis practically successful as a means of control when applied to the fuel used in malting?—I think not, I believe it affords a very valuable help, but I do not think its indications can be taken as final for the reason I have just stated—that it is very difficult to obtain an average sample, and impossible to ensure that the maltster is always making use of an average sample.

10534. In respect of statutory requirements in regard to malting fuel or anthracite, would it be practicable that the statutory requirement should be that the anthracite uniformly should contain less than a certain amount of arsenic?—I think it might be valuable to fix a standard of some kind, but I think it should be a very lax standard, for the reason I have just stated.

10535. (*Sir William Hart-Dyke.*) You mean that a large margin should be allowed?—Yes, with a large margin I think it would be helpful.

10536. (*Chairman.*) Do you suggest any statutory requirement as to the amount of arsenic allowable per pound of anthracite?—I have handed in several analyses of samples of anthracite, and I think it may be judged from the values obtained with these samples what can be done by selection, and what amount of arsenic, volatile and fixed, may be expected in the best samples.

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The analytical results handed in were as follows:—

ANALYTICAL RESULTS.

All the fuels referred to in the following tables were obtained from maltings:—

I.—ARSENIC IN WELSH ANTHRACITE.

Good Samples:		I.	II.	III.	IV.	V.	VI.	VII.
Volatile arsenic	Grain per lb.	1-30th	Nil	1-23rd	1-50th	Nil	Nil	1-140th
Fixed „	„ „	1-333rd	1-24th	1-14th	1-50th	1-24th	1-14th	1-70th
		VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Volatile arsenic	Grain per lb.	Nil	1-33rd	Nil	1-140th	1-110th	1-70th	1-140th
Fixed „	„ „	1-52nd	1-33rd	1-50th	1-20th	1-70th	1-70th	1-11th
		XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.
Volatile arsenic	Grain per lb.	1-35th	1-70th	1-140th	1-110th	1-50th	1-1000th	1-24th
Fixed „	„ „	1-35th	1-70th	1-28th	1-35th	1-70th	1-55th	1-9th

Bad Samples:		I.	II.	III.	IV.
Volatile arsenic	Grain per lb.	1-8th	1-6th	1-4th	1½rd
Fixed „	„ „	1-3rd	1-10th	1-8th	3-5ths

N.B.—Nos. I., II., and III. were slaty. No. IV. contained a large proportion of pyrites.

Pyrites (Coal brasses) from Anthracite.

		I.	II.	III.
Arsenic	Grains per lb.	7	11	3-4ths.

Shale from Anthracite.

Arsenic - - - - - - - - - - Grains per lb. 1¾

II.—ARSENIC IN OVEN COKE.

		I.	II.	III.	IV.	V.	VI.
Volatile arsenic	Grain per lb.	1-100th	1-30th	1-140th	1-70th	Nil	1-9th
Fixed „	„ „	1-16th	1-30th	1-17th	1-18th	1-20th	1-5th
		VII.	VIII.	IX.	X.	XI.	
Volatile arsenic	Grain per lb.	1-7th	Nil	1-8th	1-200th	1-10th	—
Fixed „	„ „	1-6th	1-20th	1-5th	1-14th	1-5th	—

III.—ARSENIC IN GAS COKE.

		I.	II.	III.	IV.	V.
Volatile arsenic	Grain per lb.	1-14th	1-14th	1-16th	1-25th	1-24th
Fixed „	„ „	1-55th	1-5th	1-12th	1-7th	1-8th

IV.—ARSENIC IN MALTS DRIED WITH TREATED AND UNTREATED FUEL.

Mr. J. L. Baker's Results (*see* Journal of Federated Institutes of Brewing, 1901, p. 329).

Fuel employed.	*Arsenic in Malt.*
	Grain per lb.
Coke alone	1-220th
Coke and 5% of milk of lime	1-600th
Coke and 5% of slaked lime	Nil
Coke alone	1-245th
Coke and 5% of slaked lime	Nil
Anthracite alone	1-300th
Anthracite and 5% of lime	Nil

N.B.—Mr. Baker regards any sample containing less than 1-750th grain per lb. as free from arsenic.

V.—ARSENIC IN MALTS DRIED WITH LIMED COKE—AMOUNT OF ARSENIC IN THE COKE UNKNOWN. INSTRUCTIONS GIVEN, BUT NO PERSONAL SUPERVISION EXERCISED.

OUR OWN ANALYSES.

	I.	II.	III.	IV.	V.
Arsenic - - - Grain per lb.	1-350th	1-500th	1-200th	1-370th	1-200th
	VI.	VII.	VIII.	IX.	X.
" - - - - " "	1-480th	1-290th	1-500th	1-600th	1-250th

VI.—ARSENIC IN MALTS DRIED OFF WITH GAS COKE (TREATED AND UNTREATED) AND WITH ANTHRACITE.

ANALYSES OF THE FUELS

Gas Coke (untreated):		
Volatile arsenic - - - - - - - - - -	Grain per lb.	1-20th
Fixed " - - - - - - - - - - -	" "	1-8th
Same Coke (treated with 5 per cent. of Soda Ash in solution):		
Volatile arsenic - - - - - - - - - -	" "	Nil.
Fixed " - - - - - - - - - - -	" "	1-5th
Anthracite:		
Volatile arsenic - - - - - - - - - -	" "	1-70th
Fixed " - - - - - - - - - - -	" "	1-70th

MALT DRIED WITH THESE FUELS.

	Untreated Coke.	*Treated Coke.*	*Anthracite*
Arsenic - - - - - - - Grain per lb.	1-100th	1-500th	1-500th

VII.—ARSENIC IN MALTS DRIED WITH MIXTURES OF ANTHRACITE AND LIMED COKE.

In the case of the following trials, instructions were given as to the treatment, which was at firs persona. y supervised.

Fuel employed.—Limed coke and mixtures of it with untreated anthracite.

ANALYSES OF THE FUEL.

	Anthracite.	*Coke untreated.*
Volatile arsenic - - - - - Grain per lb.	1-50th	1-55th
Fixed " - - - - - - - " "	1-100th	1-21st

ANALYSES OF THE MALTS.

Fuel employed.	*Arsenic in Malt.*
	Grain per lb.
Half limed coke Half anthracite	1-570th
Limed coke only	1-1400th
Two-thirds limed coke One-third anthracite	1-500th
Limed coke only	1-1400th
Half limed coke Half anthracite	1-357th
Limed coke only	1-714th
Half limed coke Half anthracite	1-360th
Half limed coke Half anthracite	1-360th

FURTHER SERIES OF MALTS DRIED DURING MAY, 1902.

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Fuel employed.	*Arsenic.*
	Grain per lb.
Half anthracite Half limed coke	1-360th
Half anthracite Half limed coke	1-700th
All limed coke	1-1000th
All limed coke	1-1000th
Half anthracite Half limed coke	1-1000th
Half anthracite Half limed coke	1-1000th

The anthracite and coke were the same as used in the previous series.

10537. In bad samples of anthracite you found arsenic in a volatile condition equal to one-quarter of a grain per lb.?—I have found as much as one and one-third grains per lb.

Bad samples of anthracite.

10538. You have found volatile arsenic equal to one and one-third of a grain per lb.?—That is so. Of course, these should be out of the question entirely. They would never come forward with the control now exercised. This 1⅓ grain per lb. is simply stated as an actual fact, but such a sample would, I believe, be refused at once, because it obviously contained pyrites.

10539. But in the eighteenth century such specimens would be preferred for malting?—Apparently so from the statement I have quoted.

Arsenic in coke.

10540. Coke is a more homogeneous material than anthracite, is it not?—It certainly is. It is much easier to sample coke than anthracite.

10541. But as a rule coke contains more arsenic than the best anthracite?—That is so.

10542. Oven coke contains less, however, than gas coke?—The best oven coke certainly contains less than gas coke. It is perfectly possible I believe by selection of the coal before coking to obtain oven coke as pure, as regards arsenic, as the best anthracite.

10543. You have found samples of oven coke containing as much as one-seventh of a grain per lb. of volatile arsenic?—I have.

10544. In other specimens of oven coke you found practically the whole of the arsenic has been in a fixed condition?—That is so.

10545. Have you found how much arsenic there was in the fixed condition?—In a fixed condition in specimens containing no volatile arsenic I found in two cases 1-20th of a grain per lb.

10546. And of volatile arsenic?—There was none in those two cases.

10547. The largest and the smallest amounts of volatile arsenic in gas coke were ¼ grain per lb. and 1-25th grain per lb.?—Yes.

10548. Does that apply to the largest and smallest?—Yes, in the samples which have come under my notice of gas coke used for malting.

10549. It is generally asserted that gas coke is more arsenical than oven coke; is that probably the case?—That is probably the case.

All samples from maltings.

10550. The samples you examined were obtained from maltings?—All the analyses given here are of fuels from maltings.

10551. Fuels that have been to some extent selected?—Yes, that would be presumably the case.

10552. Since the warnings of a year ago?—I should take it that they had really to some extent been selected, otherwise they would have been more arsenical.

10553. You have something to tell us about malt dried with treated coke and with anthracite untreated?—I have a series of systematic experiments with malt dried with fuel, untreated and treated anthracite, and treated coke, that is to say, treated with a base.

10554. (*Sir William Hart-Dyke.*) How treated?—Treated with 5 per cent. of lime, for example.

Advantage of liming fuel.

10555. (*Chairman.*) Five per cent. of powdered lime mixed with the fuel?—Slaked lime. If I may give the Commission some of the numbers obtained, I will do so. The last series (No. VII.) will be the most instructive, because I know everything about these. I have analysed both the anthracite and the coke. The anthracite contained 1-50th of a grain of volatile arsenic and 1-100th of fixed arsenic; the coke contained 1-55th of a grain of volatile arsenic, and 1-21 of a grain of fixed arsenic. The fuel employed was a mixture of limed coke and unlimed anthracite, or entirely limed coke. When I speak of limed coke in this case I mean this coke treated with 5 per cent. of lime in the form of cream. In one case, in which half limed coke and half anthracite were employed, 1-570th of a grain per lb. of arsenic was found in the malt, whereas when all limed coke was employed 1-1,400th of a grain was found in the malt.

10556. What do you mean by half limed?—The fuel consisted of half coke treated with lime and half anthracite untreated.

10557. Half of it treated and half untreated?—Anthracite untreated mixed with the same weight of coke treated.

10558. (*Sir William Hart-Dyke.*) That would weaken the remedy by 50 per cent., would it not? You have a portion, one-half subjected to the treatment and the other half not and then you mix the two things together?—Yes, the object of these experiments was to show that treated coke is a better fuel than untreated anthracite. If you will look down the numbers given you will see that the arsenic is the greater the larger the proportion of untreated anthracite present. In the experiments with treated coke alone the malts contained less arsenic than where anthracite was present untreated.

Proportion lime used.

10559. (*Chairman.*) The treatment is by milk of lime; how is that brought to bear upon the coke? Is it all dried with coke? You say, for instance, 5 per cent.; is that 5 per cent. of lime?—Yes.

10560. It is not 5 per cent. of the milk of lime?—No, 5 per cent. of the lime made into milk of lime.

How added.

10561. It is dried on the coke?—The coke is broken into moderately small pieces, such as the maltster uses for his firing. The lime is slaked first of all and then mixed with water into a cream, and the cream added to the fuel, and the fuel shovelled together. Or the lime is simply slaked with sufficient water, by which it falls to powder, and then also shovelled together with the fuel. That is the general mode of treatment; in fact, it is with the milk of lime treated in the way I have described that these experiments have been conducted, and 5 per cent. of lime to 95 per cent. of fuel was the proportion used.

10562. If the coke were merely dropped into a vat of milk of lime and taken out again, would that be satisfactory treatment?—Yes. In fact, I have found in former experiments that a very small amount of lime is effective, that very good results can be obtained by simply saturating coke with lime water. This was stated in the paper read by Mr. Newlands and myself before the Institute of Brewing.

10563. Saturating the coke would bring the lime water all through the body of the coke?—Yes.

10564. Anthracite could not be treated in that way?—It could not. We found that coke drenched with lime water led to a malt containing 1-300th of a grain per lb., and in another case gas coke containing about 1-25th of a grain volatile arsenic per lb. was used, it was

drenched with lime water, and the malt dried with it contained 1-400th; so that a very small quantity of lime suffices apparently.

10565. How is the coke dried after being treated with milk of lime?—Simply allowed to dry on the floors.

10566. Without heat?—Yes. There is a small amount of evaporation when placed upon the furnace, but that is nothing.

10567. But treatment of anthracite will not be so easy, because the milk of lime will not adhere to the anthracite?—That is so. My idea is this, that good selection, coupled with chemical analysis of anthracite, and in conjunction with basic treatment, should give the best result. It should, in fact, enable you to be certain of obtaining a malt containing probably less than 1-500th of a grain per lb. of arsenic. I think the treatment of anthracite with a base gets over the difficulty the maltster has in not employing an average sample every day. I do not mean to suggest using a fuel containing so high a proportion of arsenic as 1-4th of a grain per lb., or anything of that kind, but I think selection combined with basic treatment should prove successful.

10568. From what you have told us, it seems that coke, either gas coke or oven coke, treated with milk of lime, may be safer than well-selected anthracite without treatment?—That is my contention. I think the malt analyses I have given bear on this point most strongly.

10569. Do you consider that it would be safe to allow gas coke or oven coke, whichever is cheaper, to be used, provided the treatment was applied?—I do not consider that gas coke should be used indiscriminately. I think, provided proper selection be carried out, in conjunction with the control which can be afforded by chemical analysis of a sample taken from the bulk, the maltster should be at liberty to use treated oven coke or even treated gas coke.

10570. Do you believe that malt is sometimes contaminated with dust carried up mechanically from the furnace or from elsewhere?—I do. It has been stated by many authorities on the subject that that is the case, but I consider that any contamination caused by this dust can be practically ignored.

10571. The amount of it you consider to be very small?—The amount is very small, although the dust itself may contain large quantities of arsenic. I have found in the dust taken from the spreader three to five grains of arsenic per lb. The spreader is the arrangement placed over the furnace.

10572. If much of that dust gets on the malt it will make a large contamination?—I have it on good authority that 1 lb. of this dust can be caught from about 10 cwt. of coal, by an arrangement placed between the kiln floor and the furnace, and assuming the largest amount of arsenic I have found in this dust, five grains per lb., reckoning one part by weight of fuel to five parts of malt, this would lead to the contamination of 1-1,120th grain arsenic per lb. of malt.

10573. If all the dust got in?—Yes, and it is not likely to all get in.

10574. (*Sir William Hart-Dyke.*) You act as analyst, do you not, for a large number of brewing firms?—I act as analyst for some brewing firms. I act as adviser, too.

10575. Of course you are aware of all the circumstances attending what is called the Manchester scare?—Yes.

10576. In pursuing your avocation of an analyst, have you lately found traces of arsenic in any glucose you have examined?—I have, and that rather bears upon the question of controlling things by analysis, because although I have found on an average that glucose contains negligible quantities of arsenic, only recently I discovered in a sample of foreign glucose, either American or German, I cannot say which, as much as 1-12th of a grain per lb.

10577. Was that very lately?—The week before last, I think.

10578. Discovering that, you are rather led to the conclusion that this system of analysis must be very vigorously pursued?—Yes. I do not think it would be at all safe nowadays not to test for arsenic. Everything connected with brewing is tested for arsenic by analysts, I think.

10579. When you speak of the necessity of controlling by analysis, I should like you to explain what you refer to. Do you refer to a system whereby each brewer's firm should have its own analyst, and analyse all materials carefully before they are put into the beer, or some controlling power of the Government Department?—I mean at the present time every brewer is in duty bound, knowing what he does, to have all his samples tested by an analyst.

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10580. Do you think if that were done it would be sufficient guarantee to the consumer?—I do not. I think some Government steps ought to be taken to control the purity. In the meantime I should think the brewer is probably in his own interest taking steps to have all his materials analysed.

10581. You would recognise in the case of the brewer and the maltster that the result of this scare might subside?—That is what I am afraid of. Precautions against arsenic will get lax unless official control.

10582. And there might be a relapse again into carelessness?—I think that is very likely to happen, and unless some official means are taken for the control of the purity of materials I am very much afraid that things will relapse into a lax state.

10583. You quoted in an earlier part of your evidence the result of careful analysis of some anthracite, which showed a good deal of arsenic. Could you tell the Commission where that anthracite came from?—I am afraid I cannot tell the Commission that.

10584. Cannot you tell us what part of the world it came from?—It came from Wales; they are all Welsh anthracites.

10585. Did it come from collieries which would be, generally speaking, sending anthracite to those maltsters who were using it?—Yes. They were all well-known collieries. What I could do, if the Commission desires it, is to confer with Dr. McGowan, and let him see my notes, and show him exactly where it did come from privately. That might perhaps be helpful to the Commission.

10586. But they were not samples taken from a maltster's establishment?—They were all taken from a maltster's establishment; none of them were taken at the pit's mouth.

10587. They were specimens liable to be put into use?—Yes, they were all being used, everyone of them.

10588. Would you be satisfied with any very careful examination of fuel, whether anthracite, gas coke, or oven coke, without the use of this system which you have been detailing to us—the application of a base such as lime?—No.

10589. Assuming you were in the malting trade at the present moment, and were aware that a very heavy penalty might attach to you in the case of finding any arsenic in your malt, would you tell the Commission as concisely as you can how you would secure yourself?—I should not be satisfied by the control afforded by analysis only. I think it would be unsafe on account of the difficulty of sampling the fuel. I do not think the selection method in conjunction with analysis would be a sufficient guarantee. My conviction is that in connection with basic treatment it would. Selection of fuel plus treatment as with lime

10590. Do you know enough of Mr. Newlands to include him in the belief that the real security is the application of some treatment through lime or soda?—Yes, our investigations demonstrate that. These investigations have now been continued for considerably more than twelve months, and neither from my own results nor from those of other people who have tried the process have I any other than favourable evidence.

10591. I think you were urging just now, were you not, that in the case of anthracite the fuel should be carefully sampled and examined before it is used, with the addition also of the basic treatment?—That is so.

10592. Is that because the application of the basic treatment is more difficult in the case of anthracite by its not being such an absorbant as coke?—Not on account of that alone. It would apply to all fuels. I am of opinion that the selection of fuel should still be practised even though the basic method were used. I have no experiments to give the Commission in which very bad fuels have been treated by the basic process.

10593. You mentioned that, "The method has, we believe, come into general use, and it has been recommended by the Joint Arsenic Committee of the Society

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of Chemical Industry and the Society of Public Analysts." Will you kindly explain by whom this has been recommended?—I refer there to the method of analysing fuels.

10594. Apart from the system of treating by the maltster?—Quite apart. I referred to the analytical process because the same principle underlies both, the principle Mr. Newlands first pointed out, that arsenic could be retained on a technical scale.

10595. During all this period you have been analysing fuels in general use by maltsters?—Yes.

Malts will get more arsenical unless official control.

10596. You say further on, "At the present time it is rare to find more arsenic than 1-150th grain per lb. of malt." Will you kindly account for this? Is it your opinion that if a general test were applied throughout all the malting establishments this would be the result?—I do not think so. I think at the present time that things are very much better than they would be after this scare has entirely subsided. A certain amount of selection is now being used, but still one finds occasionally malts containing 1-150th of a grain per lb., or even more. Such cases are rare. I think they would be very much more common when this scare has entirely subsided unless some precautionary means are taken.

10597. You think that in two or three years' time, if nothing more were done or suggested, the examination of fuel going on now would then cease?—I do. I think it is highly probable.

10598. You are aware that we have had many witnesses here who practically condemn the use of gas-coke altogether?—Yes.

10599. They suggested that the chief security in the future for the maltster is giving up the use of gas-coke?—I have heard that.

10600. With regard to anthracite, are you aware there has been a general recommendation on the part of many witnesses as to the use of anthracite being far more secure?—Yes, and I agree with them that it is more secure than the use of gas-coke, but I do not agree that it is absolutely secure.

10601. Not secure *per se*?—I do not think so.

10602. How many samples, roughly speaking, do you think you and Mr. Newlands have analysed of anthracite?—I cannot say; I should think 50 or 60 about; more than that perhaps, at all events many more than are given in my précis. Those are analyses carried out by myself.

10603. Do these specimens of anthracite that you have examined come from different maltsters in all parts of the country, or only from the North or the South?—They come from the North, from the South, and from the Midlands. The North, as far as Lancashire. There are none further North than Lancashire.

10604. (*Sir William Church.*) Besides the great attention you have paid to the fuel, have you paid any attention to the quality of the malt for brewing purposes?—I am continually analysing malt for brewing purposes.

10605. What is your opinion as to the necessity of the fumes passing through the malt?—I have very little to say upon that matter, because I can only tell you that it is stated by certain practical brewers that it is absolutely necessary to dry malt in contact with the fumes of the furnace. Whether that be the case or not I am not able to say.

Fumes may not be essential for malt.

10606. Could you state your view to the Commissioners? Do you think that is likely to be true? Brewers may be very conservative people. We have had one witness here who said that the best malt he ever made was made without contact with the fumes?—I am inclined to think there is a great deal of prejudice in the matter, but I should not like to state that definitely, because so many brewers hold the opinion that it is necessary for the flavour of the beer. Although I can detect the flavour of the fumes in malt, I cannot go so far as to detect whether the malt used for making beer has been dried in contact or not in contact with the fumes.

10607. You see no reasons why the fumes should come in contact with malt?—I see no scientific reason why the fumes should not be entirely excluded.

Malting without fumes.

10608. Have you paid any attention to the various kilns which have been proposed? I have lately seen several plans and patents for kilns in which the fumes do not come into contact with the malt?—I cannot say I have seen any of them at work, but I am aware of the existence of various patents, and I am also aware that in the Continental system of malting the malt is entirely dried out of contact with the fumes, and in some pneumatic systems of malting, systems by which the malt is made in a drum.

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10609. Malt for lager beer is made in drums, is it not?—Not entirely. The amount of malt for lager beer made by the drum system is now on the increase; but the drum system has not found entire favour in this country.

10610. Drums are used for roasting the malt?—For the kilning. In some systems they are used instead of the ordinary malt kiln, that is to say, the grain is not only germinated in the drum, but the malt dried and cured (kilned) in the drum.

10611. I am only asking you very generally, of course, because you are not prepared to give such detailed evidence as you have given about fuel, but you see no objection to experiments being made on a large scale to see whether it is necessary that the fumes should pass through the malt?—I see none whatever. In fact, I am inclined to the view that it is not necessary. At the same time I do not feel prepared to assert in the face of many practical men who are apparently unprejudiced men, that it is not necessary to pass the fumes through the malt. From the scientific point of view there is no reason why it should be done.

10612. You see no practical difficulty in the arrangement of kilns by some system of heat radiators above the furnace heating the air to pass through the malt without direct connection with the fumes?—There are very many ways in which it could be done, but I do think it would be rather unfair to maltsters to compel them perhaps to pull down their existing kilns and build up fresh ones simply on that ground, if the same thing could be effected by other means with existing plant.

10613. That would not apply to new kilns?—No, provided there was no objection to excluding the furnace gases.

Briquettes containing lime.

10614. (*Professor Thorpe.*) Have you had any experience of the use of briquettes in malting?—Never.

10615. Do you know if briquettes are used at all?—I have heard recently that briquettes have been made up and used, but I have had no experience with them.

10616. In the manufacture of those briquettes, was any basic material incorporated?—I have been told that has been done quite recently, that briquettes have been manufactured with basic material.

10617. Are you in a position to say where the experiment has been carried out?—I do not know.

10618. And you do not know the results?—No. I should imagine very good results would accrue.

10619. Of course briquettes are made practically from powdered coal?—Yes.

10620. They would be made from materials from which presumably a large quantity of pyrites would be sifted out, and therefore, you would start with a material containing a relatively small quantity of arsenic?—You would.

Oven coking with lime.

10621. That would be a precaution?—Yes; even that, or the coking of coal in the presence of lime would be certainly a very good way of applying the basic treatment.

10622. The coking of coal in the oven in the presence of lime you mean?—Yes.

10623. That is not a practical measure in the manufacture of coal gas. The coke is the residue, and you would not advise a gas manufacturer to put lime in his oven?—It could not be done in the case of gas coke, as it would have such an influence on the products, and especially upon the tar.

10624. You would not ask the gas manufacturer to lime his fuel?—Certainly not.

10625. Would you advise in the ordinary coke oven that lime should be introduced?—I see no reason why it should not.

10626. Would it have any detrimental effect?—I see none.

Selection of fuel and treatment.

10627. If a maltster were to come to you, with your knowledge of the present condition of things, asking your advice as to what character of fuel he ought to use, what would you say to him?—I should advise him to use kilned coke, previously selected and analysed; in fact,

that is done at the present time. I am doing that particularly in one case, in which all the malt dried has been dried with limed fuel for more than twelve months.

10628. What character of coke have you advised him to select?—Oven coke.

10629. You advised him to select oven coke, and add lime water to it?—Milk of lime.

10630. In the manner you have described?—Yes.

10631. You have done that because you think that is the safest procedure you think he can adopt?—Yes.

10632. Was that sample of glucose which you analysed a few days ago, and which you found to contain that relatively large quantity of arsenic, German or American glucose?—I expect it was American; I am not certain.

10633. Was it liquid or solid glucose?—Liquid glucose.

10634. Was it used for brewing?—Yes; it was sent me from a brewery.

10635. Was it a fairly colourless glucose?—It was a glucose which had not been decolorised by sulphurous acid.

10636. That was the object of my question?—Because it was employed for brewing. I generally advise the use of samples which have not been decolorised, because the sulphurous acid has an influence on the flavour of the beer which the brewer does not like. Therefore the arsenic was in no way due to sulphurous acid. What it was due to I am not aware.

10637. Turning to the analytical evidence you gave the Commission, you pointed out that your practice was to use hydrochloric acid in preference to sulphuric acid in generating the hydrogen in the Marsh apparatus?—That is so.

10638. I think you stated you preferrred the use of hydrochloric acid because you had reason to believe the sulphuric acid rather tended to retain arsenic within the apparatus, and that you did not get the same mirror in the case of sulphuric acid that you did in the case of hydrochloric acid?—I have not stated that to-day, but that was my belief some time ago—that the mirrors were not so large with sulphuric acid as with hydrochloric acid. It has been observed by others that that is the case. What I stated was that in the case of beers, when sulphuric acid was used direct, it had been observed that it is impossible to use sulphuric acid direct, because the arsenical mirror is not so intense as when hydrochloric acid is used. When sulphuric acid is used it has been found necessary to destroy the organic matter in the case of beer.

10639. What is your explanation of that?—I do not know the reason. I have no explanation to offer.

10640. Is it the organic matter of the beer which retains the arsenic?—That I cannot say at all.

10641. Is it possible that there is any reduction of arsenic to sulphide of arsenic which does not form arseniuretted hydrogen?—I think arsenic sulphide does form arseniuretted hydrogen.

10642. Have you any experimental evidence for that?—I have added arsenious sulphide to the Marsh apparatus, and have obtained a mirror.

10643. Do you know whether the mirror you have obtained is equivalent to the amount of sulphide of arsenic?—That I do not recollect at the moment.

10644. Anyhow, it is interesting to know you have directly added sulphide of arsenic, and that has been reduced to arseniuretted hydrogen?—Yes. I believe in the dilution we use, arsenious sulphide is a soluble compound.

10645. We all know arsenious sulphide is not absolutely insoluble. If the whole of the arsenic was reduced to arsenic sulphide, the amount of fluid in the apparatus is sufficiently large to keep it in solution, and, therefore, in solution it would be reduced by zinc into the form of arseniuretted hydrogen?—May I go back a little further, and say I have experimental evidence, that when one adds a proportional amount of arsenious sulphide to the apparatus the true arsenic mirror, other things being equal, is formed proportionate to the amount of arsenic. I had forgotten it for the moment. I have done so many experiments in this arsenic testing, that one is apt to forget some of them.

10646. Salts of iron in the apparatus, whether they are introduced directly or introduced inadvertently in the zinc, seem to have some power of keeping back the arsenic, that is to say, retaining it in the flask, and in preventing its evolution as arseniuretted hydrogen?—That is so in my experience in the case of zinc containing iron—zinc which has been granulated with ferric chloride is insensitive. It has failed to detect 1-100th of a milligramme of arsenic added to the apparatus.

10647. Applying that fact to your method for the determination of arsenic in fuel, of course there is in many cases a considerable quantity of iron in the ash, and obviously if there is much pyrites there would be *pro tanto* a relatively large quantity of iron. What would be the effect of that iron in the apparatus, or even on the method of treatment for retaining arsenic?—It might be to give low results. These analyses are compared with the standards in pure water, so that it may be my results are low, especially in the case of gas cokes, which sometimes contain large quantities of iron.

10648. That is to say, you might really not be estimating the amount of arsenic which was actually in the flask owing to the presence of iron?—Quite so.

10649. But even if that were the case, and no doubt it would be the case, still, looking at it from the practical point of view, not much harm would result, inasmuch as that arsenic would be retained in the process of burning the fuel. The same operation which retains the arsenic in your flask would retain it in the fuel when burnt?—As the basic treatment is practically carried out there is no doubt it would.

10650. But the iron there would exercise a specific action in preventing the arsenic from being volatilised?—I do not know what the action of the iron is in that case.

10651. Is it not a fact that it does?—Yes, but whether it precipitates it or not I do not know.

10652. In other words, the bane contains its antidote?—I do not think we can compare what happens in the Marsh apparatus in the presence of a liquid and what happens in a high temperature in the dry state.

10653. I am talking of the high temperature in the dry state. If you roast arsenical material with oxide of iron you retain arsenic?—I believe it is retained by oxide of iron as by any other base. But I have pointed that out, I think, in my evidence, that when pyrites occurs in high grade anthracite containing but little ash, the greater part of the arsenic is volatilised during the burning. That is a fact. I found the arsenic in pyrites is practically all volatile.

10654. Do not you think that the iron which is associated in the pyrites tends to retain any arsenic?—It does to some extent, but not to a very great extent, because it does not become oxide of iron until practically the whole of the arsenic has volatilised.

10655. When the fuel is being burned, of course, the process of oxidation is going forward, and the arsenic oxide may be evolved before there is sufficient ferric oxide formed?—That is my theory.

10656. Did you ever analyse samples of spent pyrites?—No. I have analysed pyrites in the laboratory, and determined the fixed and volatile arsenic. Of course, I should have got a spent pyrites in those laboratory experiments, but I have not examined a sample of spent pyrites from vitriol works.

10657. You are aware that spent pyrites may be highly arsenical?—Yes.

10658. They may contain a large proportion of the arsenic?—Yes, they must.

10659. That is proof, of course, that the oxide of iron does act in that direction?—Yes, it is.*

10660. (*Dr. Whitelegge.*) Does this process you have described to us add materially to the cost of preparing malt?—Not at all. Lime is a very cheap substance, and I believe that the patent royalty is a penny a quarter of malt. It also enables the maltster to use cheaper fuel.

10661. With careful picking over, which I understand will be necessary in the case of anthracite on account of pyrites, would it be possible to remove the slate which you have also described as being arsenical?—I think that slaty portions could be detected.

* *Note by witness.*—It will be remembered, however, that arsenic is obtained from pyrites on a technical scale by volatilising it out by heating.

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Royalty on liming process.

Handpicking of anthracite.

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10662. You showed us two samples, one of which is slaty?—The slate is so interwoven with the carbon of the coal, it would be very difficult.

10663. In practice would the picking over for the removal of pyrites from anthracite cover the greater part of the slate?—It would cover the greater part of the impurities generally; but you can only get to a certain point with picking.

10664. It is not so easy to remove slate by picking over as it is to remove the pyrites?—The large quantities of pyrites, the visible pyrites.

10665. In the case of the black pyrites to which you referred, I understand that is disseminated in the substance of the fuel, and cannot be separated very well by picking?—That is so.

10666. I understood you to tell us that in addition to the selection of fuel and to picking over, in the case of pyrites you would rely to some extent upon analysis?—Certainly.

10667. But you pointed out difficulties in the selection of samples, and you think if it could be fixed in sufficiently broad terms some sort of a standard would be useful?—I do.

10668. I should like to know exactly in what light you are thinking of a standard. Are you prepared to suggest a figure?—I hardly think I am prepared to suggest a figure. I have brought forward a number of careful analyses, but I think that the actual figure had better be left over for the present.

10669. Still you think a figure could be fixed such as would guide you in advising your clients, and which might be defined in general terms?—I do.

Any standard test for fuel should be of volatile and of total arsenic.

10670. But you are not prepared to define it now?—No.

10671. I do not want to press you about the particular figure, but in working at a conclusion on a given sample of fuel sent to you, and on which you have to advise the maltster, do you look to the total arsenic or to the volatile arsenic?—I look to the volatile arsenic first of all, but I also look to some extent to the total arsenic. I never ignore the total arsenic.

10672. You do not regard the fixed arsenic as being negligible?—Certainly not.

10673. In what way do you think of the fixed arsenic as gaining access to the malt?—I do not altogether think of the fixed arsenic. I look at the total arsenic. It is necessary in order to arrive at the total arsenic to estimate the fixed arsenic. I do not think the fixed arsenic has any practical significance, but I do think the total arsenic has, because the conditions of burning, if the fuel is untreated, may be such that the volatile arsenic may be greater, as Dr. Thorpe has brought out, in some cases than in others.

10674. Leaving aside the volatile arsenic, the only part that remains of the total arsenic is the fixed arsenic. The total arsenic is made up entirely of fixed and volatile?—Yes.

10675. If the fixed arsenic is a negligible quantity, what is learned by looking at the total arsenic rather than the volatile alone?—I mean that the total arsenic is necessary. It is necessary, in the first place, as has been contended by a great many people, to regard the total arsenic. It may be to some extent a matter of conditions how exactly it is differentiated into fixed and volatile—conditions of burning.

10676. Temperature?—That may be the case.

10677. (*Professor Thorpe.*) What you really mean is that the proportion of fixed arsenic is not constant; it may vary with circumstances?—Yes. That is my reason for looking at the present time at the total arsenic, and for not ignoring the total arsenic.

10678. It is not constant even in a given sample?—It may be. It is constant in so far as our laboratory method is concerned, but that does not imply that the laboratory method and the practice are analogous.

10679. (*Dr. Whitelegge.*) You would attach primary importance to the volatile arsenic, and some importance to that which passed as fixed in the particular experiment?—Yes.

10680. Turning now to malt, does the difficulty of which you have told us in sampling fuel apply to malt? Is it easy to obtain a uniform sample?—No.

Sampling malt.

10681. Have you given any directions as to the taking of samples to be submitted to you?—Yes. I always direct that samples shall be taken from every portion of the kiln, bulked together, and then divided.

10682. But still, subject to careful sampling, you think that the standard figure can be fixed?—I do. I think it is much easier to obtain a uniform sample of malt, despite the fact that the arsenic is not equally distributed all over the kiln. It is easier to obtain an average sample of malt than it is of coal.

10683. I think you told us it was rare to find more than 1-150th grain of arsenic in malt now?—Yes.

Malt with less than 1-300th grain easily obtainable.

10684. And that it is commercially practicable in the way you describe to make sure that the malt prepared in a proper manner should not contain more than 1-300th?—That is the case. That is my contention. In the experiments I have personally supervised I have never found as much as 1-300th, although that is, in my opinion, an amount which can be ignored.

10685. An amount which could be ignored; you mean it is not likely to be injurious to health?—That I would not say. I am thinking now of a 1-100th of a grain per gallon limit in beer. If 1-300th grain per lb. were present in the malt this would correspond with 1-150th of a grain per gallon in the beer.

10686. I have been rather pursuing it from the other side. As the result of experience now, and while the memory of the Manchester trouble is still recent, the maltsters are turning out malt that rarely contains more than 1-150th. You are satisfied that with improvement in treatment, it can be kept within 1-300th as the limit?—I am sure it could.

10687. So that there would be no hardship, in your view, in telling a brewer he is not to allow more than 1-300th of a grain of arsenic in his malt?—I think it is perfectly possible to do that, not by analysis alone, but by analysis combined with treatment and selection.

10688. I do not think that you have given us one part of the evidence in your supplementary proof. You refer to Mr. J. L. Baker, who says that the longer the interval since the cleaning of the malt kiln, the larger the amount of arsenic found in the malt?—That Mr. Baker assures me is the case. I have not noticed it myself, but his duty is to systematically examine the out-turn of several large maltings. His entire duty is in connection with maltsters and brewers, and he tells me that, from a given malting, as the season advances so the amount of arsenic goes up, other things being equal, and the same fuel being used. I think that is an interesting observation. He tells me he can bring before the Commission a large number of analyses bearing on that point.

10689. Do you advise maltsters as to the cleaning of the malt kiln?—I do. It was one of the first things I did, after the arsenic scare, to advise maltsters to clean their kilns.

10690. Do you advise them as to frequency of cleaning?—I do.

Cleansing of malt kilns.

10691. Will you tell us how often you consider it is necessary on an average?—I think if a malt kiln is brushed down thoroughly twice during the season, it is sufficient. I think it should be cleaned after every operation to some extent.

10692. But thorough cleansing twice in the season?—Yes.

Increase of arsenic in malt as season progresses.

10693. (*Chairman.*) I have a letter here from Mr. Baker referring to the increase of arsenious acid in malts as the season progresses. What do you understand by that?—He means that, provided the malt kilns have not been cleaned, as the season progresses the malts contain a larger amount of arsenic when the same fuels are used.

10694. As the season progresses from the time of cleaning?—He means to say, first of all, portions of the malt kiln are to some extent absorbent of the arsenic, and as they become saturated with arsenic, so to speak, they become less and less absorbent, and more reaches the malt.

10695. When the kiln is cleaned is that done away with?—Apparently so.

10696. Is there a regular cleaning at definite seasons, spring cleaning, or cleaning several times a year?—I am afraid that was not done as often as it ought to have been until the arsenical scare arose, but I can only speak for those maltsters I advise.

Cause of arsenic being separable into volatile and non-volatile.

10697. Can you explain the chemical or physical difference between volatile and a non-volatile arsenic of which you have been speaking?—The non-volatile arsenic is the amount retained in the ash of the fuel. The volatile arsenic is the amount which rises as gas. It may be in any form, probably as arsenious oxide.

10698. How is the difference that makes some of the arsenic volatile and other not volatile to be explained?—I suppose it is to be explained by the nature of the inorganic constituents of the fuel, whether or not they are basic, alkaline.

10699. Is there such a difference between the arsenic in malts? Do you find volatile and non-volatile arsenic in the malts?—No. I have never tried; it has no significance.

10700. At present there has been no research or chemical investigation to discover the cause of the difference; what chemical combination the volatile arsenic is in, and what chemical combination the non-volatile part is in?—I take it the non-volatile portion is that which is held back by the basic substance of the fuel, the substances which result when the coal is burned.

10701. (*Professor Thorpe.*) In what form is the arsenic retained in association with the basic material?—The arsenic is retained in association with the basic material as sodium arsenate or calcium arsenate, which is a compound non-volatile at the highest temperature of the blowpipe.

10702. (*Chairman.*) And the volatile part is arsenite?—Probably arsenious oxide. It may be oxidised to arsenic oxide also to some extent as it rises. It may be sulphide of arsenic too.

10703. (*Professor Thorpe.*) The arsenic is partly fixed and partly volatile. That which is fixed is retained by virtue of being arsenate either of calcium, iron, lime, or some other basic substance, and that is non-volatile; that which goes away is probably almost entirely arsenious oxide. I say that because the actual crystals of arsenious oxide are often found in deposit on the plates, and have been found on the grain itself?—Exactly.

10704. There is, however, a certain quantity even of the fixed arsenic which gets on the malt by the mechanical deposition of the dust, very finely divided dust swept forward in the air current and lodged on the grain. The consequence is that when you treat malt with water the arsenious oxide goes into solution, and the merely mechanical portion carried up, and otherwise fixed, is left behind?—That is so.

10705. (*Chairman.*) Fixed arsenic in the malt or beer, if there was any, is still amenable to the Marsh test?—Yes.

10706. (*Professor Thorpe.*) Yes; it would be dissolved by the acid of the apparatus?—That is so.

10707. It would be evolved as arseniuretted hydrogen?—Yes.

10708. (*Chairman.*) It is certain that that fixed arsenic does not escape the Marsh test?—Yes.

(*Professor Thorpe.*) You asked me just now, my Lord, a question as to the formation of pyrites. The explanation of how pyrites is formed in the deposit of coal was worked out by Bischof many years ago in his essays on Chemical Geology. In the water with which the vegetable matter is soaked, you have carbonate of iron dissolved in carbonic acid contained in the water, and you have also in the water various soluble salts, *e.g.*, sulphate of lime and sulphate of magnesia. In the chemical transformation of the woody fibre into coal the sulphates are reduced to sulphides. They react upon the dissolved carbonate of iron held in solution by the carbonic acid, and you have a precipitation of black sulphide of iron. You see that in every ditch, where you see black mud: the blackness of the mud is partly due to the presence of black sulphide of iron.

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(*Chairman.*) That black pyrites is a sulphide of iron?

(*Professor Thorpe.*) Yes; sulphide of iron is black when sufficiently finely divided.

(*Chairman.*) Pure sulphide of iron is black without charcoal at all?

(*Professor Thorpe.*) Yes; it has nothing to do with charcoal.

(*Chairman.*) There is also a yellow sulphide, is there not?

(*Professor Thorpe.*) In process of time the black sulphide becomes gradually crystallised. That has nothing to do with the absorption of arsenic—arsenic may or may not be there. The occurrence of the arsenic is purely fortuitous; arsenic is not necessarily there. If the material contains arsenic, then, by virtue of the extraordinary selective power which iron salts have for arsenic, the arsenic is retained in the pyrites and crystallises with it. When the amount of arsenic gets, as in some cases, sufficiently large it associates itself with sulphide of iron, and you get a definite molecular combination of arsenic and sulphide of iron.

(*Chairman.*) Is there a definite chemical ratio?

(*Professor Thorpe.*) Yes, a definite ratio capable of being expressed by a chemical formula—FeS_2 $FeAs_2$.

(*Chairman.*) Is there a large proportion of sulphide of arsenic in such cases.

(*Professor Thorpe.*) Yes.

(*Chairman.*) Does it affect the crystalline form?

(*Professor Thorpe.*) Very slightly. You can tell at once that it is the double compound.

(*Chairman.*) What is the name?

(*Professor Thorpe.*) Mispickel is the mineralogical name given to this definite product. Mispickel.

(*Chairman.*) When the black sulphide of iron crystallises it becomes pale yellow, does it not?

(*Professor Thorpe.*) Yes.

(*Chairman.*) Has it the same chemical composition?

(*Professor Thorpe.*) Just the same, ferric sulphide—FeS_2. It has the same composition in the black as in the brassy condition, when it is known as marcasite. And marcasite.

Mr. E. S. Beaven, called; and Examined.

10709. (*Chairman.*) You have been engaged in the management of maltings for 25 years, I think?—Yes. *Mr. E. S. Beaven.*

10710. And you have had opportunities of acquiring experience of the working of a considerable number of different types of malt kilns, both of old and of recent construction?—That is so.

10711. You tell us you have lately been studying the question of the relation of the structure of kilns to the question of arsenic in malt. In this from time to time you have received considerable assistance from Dr. J. M. H. Munro, the Professor of Chemistry at the College of Agriculture, Downton?—That is so.

10712. Dr. Munro had for some years special experience in the subject of arsenic from a prolonged investigation on the effects of fumes escaping from smelting works in South Wales?—That is so

10713. Do you consider that the access of solid particles to the malt is a considerable factor—the dust carried up?—I am under the impression that if arsenic is present it would be in a solid form, or would be more likely to be in the solid form. The temperature of the malt kiln is usually under 200deg. F., and therefore if any arsenic were present in the furnace gases it would be condensed before the furnace gases reached the malt which was being dried.

10714. Do you consider that the volatilised matter in the fumes cannot contain much arsenic?—I think it cannot contain much when it reaches the malt, because the temperature is then very little above 200deg. F.

10715. The proportion of contaminating dust in the malt will vary, and the proportions of arsenic in such dust will also vary, according to the differences in the construction of the kiln?—Yes. The quantity of dust which reaches the malt will be minute, according to my experience. Construction of kiln and velocity of gas important.

10716. According to the construction of the kiln there would be more or less arsenical dust reaching the malt?—I think that the construction of the kiln will operate indirectly, but that the most direct factor is the velocity of the furnace gases.

10717. The interposition of baffle plates or other surfaces which effect condensation of arsenic and mechanically keep back the dust would have a good effect, would

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it not?—I should prefer the expression screens or filters to baffle plates. I do not quite know what is meant by baffle plates, but I think they would be useful.

10718. Something not to be used as a filter, but something which would cause the dust to be deposited on the plate. But you think a filter better than a baffle plate?—I prefer a perforated structure.

10719. You say that one important factor is the velocity of the hot air and accompanying gases from the fire, which is sometimes very high. For instance, in the case of tall kilns with several floors?—I have no experience with kilns of several floors.

10720. Is there only one floor in a kiln?—In the majority of kilns there is only one drying floor. Kilns are constructed with two drying floors, and sometimes three, but I have had no experience with such kilns. The floors which I refer to in my proof are not drying floors, but working floors. There has been recently a tendency to build maltings higher than they were formerly built. The old method of building maltings before much machinery was used was to build two working floors, germinating floors, one above the other. Generally then the kiln was on a level or somewhat above the third floor. That would carry it to a height of perhaps 15 or 18 feet from the ground.

10721. From the furnace?—Yes.

10722. (*Sir William Hart-Dyke.*) What is the space between the two working floors?—Eight feet, perhaps.

10723. (*Chairman.*) Does a man walk about on each floor and turn the malt?—Yes. Recently there has been a tendency, in order to economise space, to build more floors, and many maltings have been built with four germinating floors, one above the other. The kiln in these newer maltings is frequently, not in all cases, at a higher elevation above the furnace.

10724. How does the velocity compare in the two cases of one floor or several working floors? Is the velocity of the fumes nearly the same in the two cases?—When the drying floor is a great height above the furnace it is much easier to obtain a great velocity in the furnace gases.

10725. You obtain your hot air through the ascentional hydrostatic pressure?—Yes. I do not think it is always the case that velocities are higher, but I think they would tend to be higher in high kilns, but they would not necessarily be higher.

10726. The malt is carried from the germinating floors to the drying floors?—That is so.

10727. It is never dried on the germinating floor?—Never in my experience.

10728. The germinating floor is always on one level. There may be several levels, but the germination is the same on the different levels?—That is so.

10729. What do you call the working floor?—What we call in technical language the working floor is the germinating floor.

10730. Where there are several working floors, is the malt dried all on one floor?—I am only acquainted with kilns with one drying floor in which the malt is dried on one perforated floor. Kilns are constructed in which there are two perforated floors, one above the other, but I am not acquainted with the working of such kilns.

10731. In those kilns the fumes would pass through the lower floor and then through the upper floor?—Yes.

10732. And there are kilns with as many as two drying floors, and sometimes three?—Yes.

10733. Do you think that the arrest of arsenic can be effected by reducing the velocity of the gases leaving the fire?—Yes, provided a considerable proportion of the air be heated before admixture with the furnace gases. That, I believe, is accomplished in some high kilns at present. Not all the air derives its heat directly from the furnace, but some heat is communicated to the air which is used for drying the malt indirectly. In other words, there are channels through which a considerable volume of heated air passes without coming into contact with the furnace at all.

10734. So that a large part of the drying is done by air which has not been through the fire at all?—That is so.

Fumes believed to be essential for flavour.

10735. Do you think the whole drying of the malt might be done by heating the air in tubes or by plates without passing it through the fire at all?—I have no doubt that if the end in view is simply to reduce the moisture content to a certain point that might be done.

10736. And is not all that is wanted to dry the malt to a proper degree to grind it and prepare it for the commencement of the brewing?—I am not a brewer, and I find that most brewers think not. I imagine that the product would not be the same.

10737. What would be the difference?—I should suppose that the fuel gases have some antiseptic properties.

10738. Supposing that you could get absolutely pure carbon for fuel, would the result be good; would you like a little peat reek along with it?—I think not.

10739. Do you think that pure charcoal for the fuel, setting aside the question of expense, would give the best results?—I imagine there would be no antiseptic value in the fumes from pure charcoal.

10740. What ingredients might give antiseptic value—sulphur?—Yes.

10741. It used to be considered in the year 1742 that sulphur in the fumes passing through the malt in drying was useful as bleaching the malt and giving a fine colour to the beer?—I do not think any importance is attached to that at present.

10742. Is there any other idea about antiseptic property than that which sulphur could give?—I imagine there are other volatile bodies in fuel gases other than sulphur.

10743. Has arsenic, for instance, a fine antiseptic property?—I have no knowledge, but I imagine not.

10744. It has been stated in evidence before us that the flavour of the beer would not be satisfactory if the malt were dried with pure hot air?—I am not a brewer, and I do not know whether that would be so. No reason occurs to me, except that I have already said that there may be, and I think probably there are, some antiseptic properties in furnace gases.

10745. It would be very different with different fuels. For instance, gas coke, oven coke, anthracite, and pure carbon would all have different qualities in respect to any supposed antiseptic substances?—I imagine the pure carbon would have none.

10746. But all forms of impure carbons would have some of that supposed antiseptic quality?—I suggest it is possible; I have no evidence on the point.

10747. Have you any reason to believe that there is a different antiseptic or other quality in the fumes of gas coke, oven coke, or anthracite?—No, I have no evidence.

10748. So that practically you do not feel convinced that pure hot air might not have as good an effect as the fumes from those three different kinds of fuel that are practically used?—No. I am quite open to conviction. I have no strong opinion. I suggest that flavour is a thing which is unaccountable to a great extent. I do not know whether it would be out of place to relate an opinion that was once expressed to me with regard to the difference between Scotch and Irish whisky. I was once going through one of the largest distilleries in Dublin, and I asked the manager if he would explain to me what the difference between Scotch and Irish whisky was. He pulled a very long face, and said in a very solemn manner, "That is a very important question, but I think it is a question you had better not ask me.' My impression was that he did not know, and that it is not an accountable difference. There may be just as much difference, which we are not able to account for, between the product of drying by pure air and with gases containing matters derived from fuel.

10749. One difference that seems possible would be the difference between hot pure air and hot carbonic acid, carbonic oxide, and air?—Yes: but I cannot imagine anything would be due to the difference between hot carbonic acid and air.

10750. Or carbonic oxide and air?—I cannot imagine any difference.

10751. Can you imagine anything that is common to the three kinds of fuel, oven coke, gas coke, and anthracite, that would give a flavour to the malt?—I think some flavour is given.

10752. Would it be different between gas coke, oven coke, and anthracite?—It is slightly different. I think I could tell myself the difference, although I am not sure, between the malt which was dried with coke and one which was dried with anthracite. I do not know why, but some brewers prefer the flavour of malt which is dried with coke, and others prefer the flavour of malt which is dried with anthracite.

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10753. Chemists cannot test the difference which accounts for the different flavours?—No. There may be difference of flavours impossible of analytical estimation.

10754. It seems difficult to imagine that there is a subtle flavouring matter in anthracite and in gas coke and oven coke, and that it is the same in those different substances, and that there would not be anything of the kind in pure charcoal?—I admit the difficulty of understanding or explaining it, but I suggest very respectfully that it is no more difficult of explanation than is the difference between many other flavours to which the public attach importance, such, for instance, as the difference between the flavour of Scotch and Irish whiskey.

10755. In Scotch whiskey there is a great deal of the peat reek flavour which is not done away with in the distillation?—It is extremely difficult to say how it gets into the whiskey.

10756. The malt is dried with peat mixed with fuel?—I am told that is often not so. I am not acquainted with the process, and therefore have no evidence.

10757. You have heard the name of peat reek as giving a flavour to whiskey?—Yes.

10758. That is from the use of peat; but that may be a thing of the past. There may be little peat used now?—I am told that it is not used generally.

10759. (*Professor Thorpe.*) I believe it is used?—It may be. I have no personal knowledge.

10760. You say you cannot conceive there should be a possible explanation of any difference, but I may point out to you that there is a fundamental difference in fuel, such as coal, coke, and charcoal. It is not a mere question of hot air. All coal contains a considerable quantity of nitrogen, and when the coal is heated the nitrogen is evolved as pyridin-, picoline, and bases of that character. These nitrogenous bases are present in an extremely small quantity, but they have the most penetrating smell, and even a piece of paper brought into the atmosphere of three or four drops is impregnated. There are specific flavours which are practically almost imponderable when you afterwards try to assess them, so to speak, as actual entities. It certainly is so in the case of whiskey. Matured whiskey contains an extremely small quantity of furfural, an aldehyde, present in whiskey to a very small extent, especially in matured whiskey. Whiskey that is deprived of the last traces of furfural is unmerchantable?—No doubt.

10761. (*Chairman.*) There may be a difference between pure air and fumes, in that the pure air has oxygen and the fumes comparatively little oxygen. Could that affect the germinated grain in the drying malting?

(*Professor Thorpe.*) In fumes there is any amount of oxygen?—There is something distinctly recognisable in the fumes which come from malt. As between, say, anthracite and oven coke there is a distinct difference in the fumes recognisable to the senses. They are very distinctly recognisable by the smell, and I think it is highly probable that they communicate some different flavours to the malts. Indeed, the aroma of the malt dried with different materials differs. I think the difference is quite comparable to the differences between Scotch and Irish whiskey. I do not mean that it is similar to either, but the difference is comparable. I suggest that it is just as probable that these differences have something to do with the character of the ultimate product, as in the case of whiskey.

10762. (*Chairman.*) You think there may be a perceptible difference in the flavour of beer according to whether anthracite, gas coke, or oven coke has been used in the malting?—Yes.

10763. Whatever flavouring essence there is one would expect it to be very different in the case of oven coke and anthracite?—I am not competent enough to say how far one would expect it to be very different. I speak from experience that it is somewhat different, but I suggest that it is undoubtedly very different from what would be obtained by pure hot air.

(*Chairman.*) Would charcoal have a very definite smell?

(*Professor Thorpe.*) It depends on the charcoal. One form of charcoal will give a kind of fume that another form of charcoal will not. The fume that comes from oak charcoal is very different to that which comes from dog-wood charcoal.

(*Witness.*) Until recent years, and I believe even now, in the manufacture of one or two special types of stout, wood is still used in the drying of the malt.

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10764. (*Chairman.*) Uncharred wood?—Usually I believe beechwood or oak faggots or billets. I am not sure what wood is generally used. I have not used it myself.

10765. That gives a very decided flavouring to the malt and the beer?—Yes, and it is used with that object.

10766. It may be a very agreeable and wholesome flavour?—Yes.

10767. (*Professor Thorpe.*) The point is that it is used with that object?—Yes. It is used with the object of giving a particular flavour. There is a brewery with which I was acquainted which until recently used it, and as far as I know it is used now.

10768. (*Chairman.*) That is a most important statement with regard to the knowledge we are wishing to elicit. Coming back to what Dr. Thorpe has said with reference to nitrogen in anthracite and other coal, is not that nitrogen driven off altogether in the coking?—(*Professor Thorpe.*) Very largely. To that I ascribe the difference that Mr. Beaven has pointed out, that he can differentiate between malt dried with anthracite and that dried with coke?—I could sometimes do it. I do not suggest that anyone could do it infallibly.

10769. The fact is that it is so. In the tar derived from the coke, those things are obtained. There would be less of the flavour generating substance in the coke than there would be in the anthracite that contains the nitrogen?—Yes.

10770. (*Chairman.*) According to that, it would seem that while there still might be flavouring essences when coke, whether oven coke or gas coke, was used, there would be less of flavouring essences with these cokes than with anthracite?—Probably.

(*Professor Thorpe.*) There is that probability. I merely put forward this in answer to your difficulty, that it was mentally inconceivable to you how such a thing might occur. I pointed out that there is the fact of the nitrogenous constituents to be reckoned with. I have no evidence whatever that these nitrogenous materials are to be found in malt. That is not the point.

(*Chairman.*) My view, which is probably not correct, was that cokes are a near approach to pure carbon, and an approach in which volatile organic matter would probably have been destroyed, but from what Dr. Thorpe now tells us it seems that even a process of coking is not sufficient to destroy some of those subtle flavouring materials.

(*Professor Thorpe.*) The coke still contains nitrogen.

(*Witness.*) I believe the extent to which cokes are burnt also varies very much. I believe it is common sometimes to burn oven cokes in ovens for as long as three days. I believe that gas cokes, on the other hand, are only burned for a very short time, sometimes six or eight hours, and that oven cokes are burned with the access of a limited quantity of air to the oven, which I believe is not present in gas ovens. I suggest, still with much diffidence, that even those factors might make some difference to the flavouring material.

Furnace gases should be cut off when fire is stirred.

10771. You consider it important to cut off the furnace gases when the fires are stirred?—Some dust in all kilns rises from the fires when they are stirred. I think it is a cleanly thing to do to fit a swing valve to keep that dust out of the hot air chamber. It does not necessarily follow that it finds its way through the drying floor, but I think as a safeguard, and as a measure of cleanliness, it is a desirable thing to cut off the furnace gases and check the velocity of the furnace gases by closing the aperture which leads from the furnace into the chamber at the time when the fire is stirred, when there is such an aperture.

10772. (*Sir William Hart-Dyke.*) What happens if this precaution is used?—Nothing.

10773. The furnace fumes do not ascend?—No. The fire burns temporarily with less vigour.

10774. They are practically destroyed by this process you mention?—The current of air is stopped.

10775. If you do not stop this current of air, you say in the passage of the air there would be certain particles which might go through the perforated floor and affect

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the malt?—It is an undoubted fact that some dust when the fires are stirred goes forward. I think it is desirable as a matter of cleanliness to prevent that. It is such an easy thing to do.

10776. What happens to this dust?—It collects within the distributing chamber.

10777. And would be deleterious would it not, unless it were removed?—I do not suggest that any appreciable quantity of it reaches the drying floor, but I suggest as a matter of precaution, it is desirable to keep it out of even the distributing chambers.

10778. (*Professor Thorpe.*) You mean keep it within the furnace?—Yes. It goes down with the ashes: when the fire is stirred, instead of the dust flying forward, it simply goes through the fire-bars.

10779. (*Chairman.*) There is a great deal of dust mixed with the air during the stirring, which, if you give it a few minutes, will settle into the fire again?—Quite so.

10780. Cleaning out the furnace would involve sweeping away the dust?—Yes.

10781. The dust is cleared away at certain times?—That is so.

Use of screens for filtering and condensing arsenic.

10782. You suggest also that the interposition of screens kept below 300 deg. F. which act both as filters and condensers of volatile matter would be useful?—I find it in practice very useful.

10783. Why do you fix upon 300 deg. F.?—Because I believe that at that temperature arsenical matter, if present, will be at any rate largely condensed.

10784. You believe that arsenical matter cannot be carried up in practically deleterious quantity in air at a temperature of less than 200 or 300 deg. F.?—That is my impression.

10785. (*Professor Thorpe.*) Arsenious oxide requires a much higher temperature than that to volatilise it?—I presume so.

10786. (*Chairman.*) You point out that the fumes as they go through the drying floor are essentially at so low a temperature that they would not carry volatile arsenic, and that the chief way that arsenic does get into the malt is in the form of dust?—That appears to me to be so.

10787. That is a very important conclusion. You would also treat the filters you interpose with lime, in order to fix the arsenic. Do you think that is important?—I have found that a certain amount of arsenic—not a large amount, because I use fuels, anthracites, that contain only a very small amount, a negligible amount—but I have found that of that small amount some is arrested in combination with lime, when lime is placed near the furnaces, and when the furnace gases are at a high temperature, and when also there is a supply of water vapour, or of the elements of water somewhat greater than that which is contained in the furnace gases themselves.

Use of lime to intercept arsenic.

10788. But those filters that you propose to be kept at a temperature below 300 deg. F., would not want lime?—No, I do not think lime would be of any service.

10789. But you would place lime in the hotter filters below those?—Yes. I have done that. I have passed the furnace gases, in a kiln which has been fitted with a filter of this description, at a high temperature through lime, and I find that the lime absorbs a substantial proportion of the small quantity of arsenic which is present in the anthracite coal which was used.

10790. How do you place the lime, in powder or small lumps?—I have tried many different ways, and I am still uncertain as to the best method of using lime, and I am still endeavouring to find out the best method.

10791. Do you know Newlands' patent?—I do.

10792. Did you hear the evidence given by the last witness?—Yes.

10793. Have you any experience of the efficacy of lime or other bases on the fuel itself?—Mr. Newlands and myself have been in constant communication. I think that my plan is in effect the same as Mr. Newlands. It is to bring the products of combustion at a high temperature in contact with an active base for the purpose of fixing arsenic in a non-volatile form.

10794. Have you experimented at all upon the lime you have used in that way in keeping it for a considerable time to see whether arsenic is caught by it?—Yes, it is. I have made a good number of estimations in my own laboratory, and they have been made for me by others, as to the arsenic which is taken up by lime so placed.

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10795. Do you find it corresponds to the quantity of arsenic which may be supposed to be volatilised from the fuel in the fire?—That is very difficult. It is difficult to make such a comparison, because it is practically impossible to know how much there was in the fuel. I have some experimental results, but I regard these results as preliminary, and I should give them with much hesitation, because I regard them as requiring to be confirmed. I think you would say that this is a matter in which it is necessary to proceed with caution, and in which it would be very foolish to draw conclusions on insufficient premises. All results of this kind need to be carefully established before they are given with any confidence as results, but I have no doubt of the general proposition which I have made, that when lime is placed in the path of furnace gases from anthracite some arsenic is absorbed, if there is also the supply of a certain amount of water vapour or of the elements of water at the same time. I have a model of an apparatus at the office of the Commission which I think would illustrate the point.

10796. We will take the opportunity of looking at it afterwards. In the meantime, is there anything more you can give, whether the results of preliminary experiments or otherwise, bearing on what you have just told us and confirming it?—I have got a book full of results, but I would rather confirm them. I will, however, give you some if you wish.

Quantity of dust from burning anthracite intercepted on screens, &c.

10797. We should be very glad to have some?—They are to be understood as preliminary results, and I will not guarantee their accuracy. From the consumption of 2,000 lbs. of anthracite I recovered 1,290 grammes of furnace dust, in the filter as I call this lime apparatus, and in the condensing curtains together, which is equal to ·15 per cent. of the coal, or 3 lbs. per ton of coal. In that, and in the lime which was used in the filter, I estimated that there was arsenious oxide equal to 1-60th of a grain per lb. of the coal.

10798. Of the coal originally used?—Yes, or 1-400th of a grain in the malt which was dried.

10799. That is, if all that powder had gone into the malt?—Yes; but I do not suggest, or suppose, or believe for a single moment, that any considerable proportion of that would have reached the malt. If it had not been arrested just where it was it would have mainly, almost wholly, I think, have been collected in the distributing chamber of the kiln as dust.

10800. Did you hear Mr. Ling's statement in evidence that very little of the arsenic found in malt can be due to dust?—Yes; I understood he meant very little comparatively.

10801. There is definitely a certain amount of arsenic found in the malt?—Not in all malt.

10802. The arsenic that is frequently found in the malt, according to Mr. Ling's judgment, could not have come to the malt from the dust, but your view is that it could not have come in any other shape than dust?—If condensed matter is also included in the term "dust."

10803. Certainly it is?—Then I would not say it could not, because I believe that where a body has a condensation point of a certain degree of temperature, it may be possible that some condensation fails to take place just at that particular point, but with that proviso I think it is extremely improbable that other than extremely small quantities of arsenic could reach malt as volatile arsenious oxide.

10804. Did you notice the observation and experiment on which Mr. Ling founded his conclusion?—I did not.

Such dust would contribute very little arsenic to malt.

10805. Could you explain the opinion given by Mr. Ling? He said, "I have it on reliable authority that for every 10 cwt. of coal used, 1 lb. of dust may be caught by an arrangement placed between the furnace and the kiln. Assuming this dust to contain 5 grains of arsenic per lb. and reckoning one part by weight of fuel to five parts of malt, if the whole of this dust reached the malt it would only contaminate it to the extent of 5 grains of arsenic per 50 cwt. of malt, or 1-1,120th grain per lb.?—That I think is quite right.

10806. Do you think then that there must have been a considerably larger portion of dust that may have reached the malt not caught in the arrangement described by Mr. Ling there? Far and away larger quantities than the amount mentioned have been found in malt?—No doubt.

10807. He has it on reliable authority that for every 10 cwt. of coal used 1 lb. of dust may be caught?—Yes, 1 or 1½ lbs.

10808. Do you consider that in these data of Mr. Ling the dust caught was exceptionally free from arsenic?—No. I have no reason to suppose it is exceptionally free. I have never had any acquaintance with fuels with any large proportion of arsenic in them. I should think that is about normal as far as I am aware, and it corresponds with my own experience.

10809. That would give what we are considering practically free from arsenic, only 1-1,120th of a grain per lb., which is generally considered to be so small a quantity that it could not produce any injurious effect?—That is one of my contentions.

10810. Then in cases in which the malt has as much as 1-100th of a grain of arsenic, there should be far more arsenic in the powder caught above the furnace?—Or some abnormal conditions under which a far larger proportion than usual of the dust reached the malt.

10811. But if the whole dust reached the malt, Mr. Ling contended it would only give 1-1,120th of a grain per lb.?—It has been always a great mystery to me where these quantities come from which have been quoted as being present in malt.

10812. Do you think that a considerable amount of volatilised arsenic may have been passed through, over and above this dust described by Mr. Ling in the statement I have read?—I am wholly unable to account for the presence of material quantities of arsenic in malt. I have had no experience of such quantities. I do not think I can give any explanation.

10813. Have you tried your lime filter with fuel containing larger quantities of arsenic?—I have not, except absolutely experimentally, from which I have no results I can quote.

10814. Do you intend to continue your researches on the subject?—I do.

10815. The Commission will be grateful to you if you communicate the results of further experiments, particularly with the object of finding whether or not the distinctly arsenical fuel, fuel with more arsenic in it than that which we consider as admissible, does give volatilised arsenic which is removed by your process of a basic filter applied hot, or by condensation on the colder screens?—I will do what is possible experimentally.

10816. I think we may see how, without suspecting the accuracy of anything put before us by Mr. Ling or yourself, the dust might be carried in an exceedingly subtle form. You hold that the arsenical vapour is essentially condensed to dust before the fumes reach the temperature of the drying floor. That may be. But all the arsenic may be there as dust, and yet be thoroughly carried up with the fumes just as if it were gas. Dust if fine enough is carried with air just as thoroughly as if it were gas?—Quite so.

10817. Your process would consist in passing the fumes through a hot basic filter, and leaving the filter at a temperature somewhat near that of the drying floor?—No, it would leave the basic filter at a higher temperature, and there would be condensing curtains above that where the gases would be mixed with a considerable volume of cold air entering from cold air inlets, and where the temperature would be reduced to approximately 300deg.

10818. You think that the thoroughly volatilised fumes, if hot enough, will act upon the lime in such a way as to leave the arsenic in the lime, and the fumes go out still hot?—Yes, two things being provided: that the mass of filtering material and the quantity of filtering material in relation to the total volume of air going through is sufficient. A thin layer will not accomplish much. Therefore there must be a considerable body or mass of basic material for the gases to come in contact with.

10819. Would it be a layer a foot thick, for instance?—I would not like to commit myself.

10820. An inch thick would be quite insufficient?—Quite.

10821. A foot might be sufficient?—It might be sufficient. I believe from my experiments, provided also that there is the presence of the elements of water.

10822. How are those supplied?—Those are supplied partly by what is contained in the products of combustion, but I think this is not sufficient. In the apparatus of which I have made a trial I place a vessel under the basic filter, and I use it not only for the purpose of conveying a small quantity of water vapour or the elements of water at a high temperature to the basic filter, but also as a washing vessel for cleansing the filter.

10823. The filter is at a high temperature?—Yes.

10824. You cannot wash that with water?—Yes.

10825. It is at a temperature far above the boiling point of water?—Yes.

10826. How could you wash it with water?—Do you pour water down through it?—I can demonstrate it to you if you will allow me to show you the model. It is a comparatively simple structure. It is a mechanical arrangement by which the filter is simply immersed into a washing vessel.

10827. Sunk down temporarily; immersed, cooled, and brought up again?—Yes. It has been objected that the water is objectionable, that you are giving the furnace more work to do to drive off that amount of water and the water in the malt. That is so, but the quantity of water is absolutely negligible in relation to the quantity of malt. For instance, in a comparatively small kiln the quantity of water which would be driven off the malt would be ten tons of water in four days. The quantity of water which it would be necessary to use in connection with this apparatus might be 100lbs. or 200lbs.

10828. How often would this washing be performed?—As often as necessary—every day or every hour; it could be performed with the greatest facility.

10829. How often have you done the washing in practice?—In practice once every four days.

10830. That would not give sufficient of the material of water?—No; but there is water permanently underneath permeating through, dry steam.

10831. Water is evaporating under your lime filter?—That is so. I wish to add that the character of the arrested matter will depend on the temperature, but the quantity of it will depend upon the velocity.

10832. The velocity of the fumes upwards?—Yes, but I wish to explain that what is important is not their velocity when they leave the fire, but the velocity when they pass through the malt, and the velocity is much smaller than is commonly supposed. I believe there is a common idea that volumes of air are taken through the malt at great velocities. That is not the case. The theoretical velocity which is required, and which I have demonstrated by means of laboratory appliances, is less than two feet per minute.

10833. (*Sir William Hart-Dyke.*) You have had very considerable experience in the malting trade in all its bearings?—I have.

10834. You have been amongst maltsters constantly for the last 20 or 25 years?—Yes. I cannot pretend to have any authority to speak on behalf of maltsters generally.

10835. I am not asking that, but as your general experience you have had the advantage of hearing their views, and you know a great deal of the ins and outs of the trade?—Yes.

10836. You are also a practical maltster yourself?—Yes.

10837. I should like to ask you one question with regard to a question put to you by the Chairman as to altering the malting system by a process of pure air. The question arose as to matter of taste. It is rather an important matter, is not it, as regards the brewing interest?—I think it is a very important matter. I think it would need very strong compulsion indeed by some superior authority to induce brewers and maltsters to give up their system.

10838. It is quite possible that if a new system was introduced such as this, brewers might be at very considerable loss by having their beer sent back by customers who rejected it?—It is quite conceivable.

10839. Without really going very closely into this matter of taste, it is perfectly obvious, is it not, that the consumer of beer is very quick indeed at discerning anything fresh in the beer, that the slightest possible change is sure to be detected?—There is no doubt about that.

10840. I notice you state here that you "believe, therefore, that it will be found possible to provide in

several distinct ways for the effectual arrest of arsenical matter in malt kilns without having recourse to indirect drying," the indirect drying being the other process?—Yes.

Dilution of furnace gases with air.

10841. You mention one or two processes which you think will be thorough and effectual. The first is by reducing the velocity of gas leaving the fire and providing for a considerable proportion of the air to be heated before admixture with the furnace gases, and you said, with regard to that, that this will require in most existing kilns considerable structural alteration?—I think it is a point which may be borne in mind in the building of new kilns, that it would not be a difficult matter to provide. I am aware of some kilns which have already some device of that kind. That is obviously a matter of the structure of the kiln.

10842. If all maltsters were forced to make this change in existing buildings and existing apparatus it would be rather a serious charge on their business?—Yes, very.

10843. Then we come to the proposal which you have heard a good deal about from Mr. Ling with reference to the treating the fuel with a basic material with a view to the fixation of the arsenic in a non-volatile form. With regard to that, I think you suggested a different process from that Mr. Ling put before us?—I suggest that the process is practically the same, and that it is quite the same as to its effects. What happens is that the products of combustion are brought into combination with basic matter in both cases.

10844. (*Chairman.*) Hotter in Mr. Ling's case than in the process you suggest?—Yes; but by placing the basic matter immediately over the fire the temperature might conceivably be as high in the filter.

10845. (*Sir William Hart-Dyke.*) I presume there is a process of experiment on in reference to this matter?—Yes.

10846. And is likely to proceed for some months?—Yes. It has been going on for some time.

10847. I should like you to tell the Commission whether it is not a fact that in either case the cost of what you have suggested would be really very small?—Comparatively small.

10848. Have you any idea of what your system—how much per quarter of malt the expense would be?—The total expense would be 2d. or 3d. a quarter—roughly—at a guess.

Cost of applying his system.

10849. Have you any doubt in your mind, if these experiments proceed for some months and a conclusion is reached as to the best process to be adopted for this basic treatment, that security for the drinker of beer in future will be assured by some such process as this?—I have no doubt that the complete security of the consumer can be secured, but I must be allowed to say that I think the consumer already has security. I am unable from my experience to understand how it is possible for any quantity which could possibly be considered deleterious to be present.

10850. Can you tell us the number of analyses you have made for the detection of arsenic in malt?—I have only made the experiments during the last two years.

10851. Since this occurrence at Manchester?—Certainly. One never supposed before that that there was any arsenic. I have with me records of 385 determinations, not all upon malts—upon malts and furnace products. That is exclusive of a large number of preliminary matters. Those are done by the Marsh-Berzelius process, and they are exclusive of a large number which were done by processes suggested earlier.

10852. You expressed surprise just now at some of these statements placed before us as to the quantity of arsenious oxide found in malt?—Yes.

10853. You express this surprise after your experience. During the two years you have been analysing you have not found these results yourself?—I may say that the results which have been reported to me by professional analysts—I am not a professional analyst—lead me to the same conclusion.

10854. You "desire to say you are of opinion that the malts hitherto produced in this country have been free from arsenic in any other than such minute quantities as there is no evidence to show have been prejudicial"?—That is my opinion.

10855. (*Chairman.*) There is a large amount of evidence of ordinary malts having considerable quantities of arsenic. We have had a good deal of evidence that there is a certainly dangerous amount of arsenic in a considerable number of malts?—I think the conditions must be quite abnormal in some respects I have no experience of and cannot account for. I cannot give evidence about what I know nothing.

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Severe official restrictions on arsenic in malt not needed.

10856. (*Sir William Hart-Dyke.*) You are strongly of opinion that onerous restrictions such as would materially interfere with trade should not be imposed?—I am.

10857. You do not consider them at all necessary?—I do not think onerous restrictions should be imposed.

10858. (*Professor Thorpe.*) You obviously consider that some degree of restriction should be imposed, that something should be done to meet the difficulty raised by arsenic in malt. We cannot let things go on exactly as they were. What have you to say to that?—I think that is rather a matter for the Commission than for any individual.

10859. You have given a great deal of attention to this matter, certainly more than any individual member of the Commission. You have been at it continuously for two years. Would you give the Commission the benefit of your own conclusions on that point?—I must say that I think with regard to malt the public mind has been unnecessarily alarmed.

10860. But if it is the fact, and we believe it is the fact, that now and again—I do not say on a very considerable scale—but now and again we meet with quantities of malt which contained arsenic to a deleterious extent, and proved to be a deleterious extent, surely that is a condition of things which calls for some dealing with—that you must admit, do you not?—Yes; if the amounts have been proved to be deleterious, I think it is a state of things which ought to be rectified.

10861. Cannot you, in the light of your experience in treating malts, give the Commission the benefit of your own experience, and say what is the best way of meeting this condition of things? What should be done? If you were in our place, what would you recommend should be done?—That is an exceedingly difficult question.

10862. I suppose it is capable of being answered, is it not?—I cannot say that I have approached the matter from that point of view.

10863. Well, I present that point of view now to you. What would you recommend us to do? My object is simply to get the benefit of your knowledge and experience on this point?—I do not think that a standard test for malts to which malts should conform would be objected to. I mean a test which would have the effect of providing that no arsenical malt should be used—that is, with deleterious quantities.

10864. Do you think that would not be objected to?—I think that would not be objected to, provided the test were not an academical one and the quantity were not an academical one. I look on some of these minute quantities here as academical quantities, not quantities at all—something for which we want some other word than the word quantity.

10865. I quite gather your meaning. You say that you think the trade in general would not object to the imposition of certain limits of the amount of arsenic which should be contained in the malt?—I have no kind of authority to speak on behalf of the trade.

10866. But that is the impression you seek to convey to us. You have reason to hope, at all events, that they would not object to it?—I do not think I should be personally put to any inconvenience by the imposition of a reasonable test applied to malt.

10867. A reasonable test with a reasonable limitation?—Yes.

10868. We will separate the two things; never mind the test for the moment. What do you think would be a reasonable limitation?—I do not know. I think that is a medical question.

10869. Looking at it from the point of view of practice, of what can be obtained by ordinary care without any degree of difficulty, what is a reasonable amount, without the imposition of onerous conditions, or great constructional alterations, or anything out of the common?—I do not think that with anthracite coals, or with good oven cokes even—I cannot say with regard to gas cokes—I doubt if malts would be produced, except under extremely abnormal conditions, containing more than 1-200th of a grain to the lb., and 1-200th of a grain is an extremely small quantity.

10870. That would be 1-100th of a grain per gallon of beer?—About the same.

10871. In other words, it comes to this then, that no beer ought to be sold containing more than 1-100th of a grain per gallon. That is a practical condition even now. Is that your point? Such conditions you know would secure the beer with not more than 1-100th of a grain per gallon?—You mean contributed by malt?

10872. Contributed by malt. Assuming the beer to be a whole malt beer?—Yes, that would be so.

10873. That you think is a reasonable degree of limitation to ask for?—There are other questions which arise, when I am asked a question of that kind, especially the question of the analytical methods which are employed. If too severe a test is imposed it becomes immediately within what I believe to be the error of experiment of the Marsh-Berzelius process. I believe the unavoidable error of experiment of the Marsh-Berzelius process is not inconsiderable in relation to such small quantities as have been suggested. I foresee the possibility of great difficulties, and, perhaps, some contentions arising.

10874. If I have gathered your meaning correctly, you wish us to believe that when we impose a limit, if we do impose a limit, that the limit should have some reference to the nature of the analytical method involved?—Yes.

10875. But, assuming that the analytical method involved were of a character to actually, without much reasonable doubt, indicate 1-100th of a grain, what is your point then—assuming that the analytical method were all right? I do not see exactly how the question of the analytical method comes in, because we have assumed that the analytical method is valid, and there ought to be no question about that?—In dealing with these extremely small quantities, these practically intangible quantities, I do not know how any person who is not both a chemist and a medical man of experience can possibly have an opinion. I do not come within that category, and, therefore, I venture to think that I have not sufficient grounds to form an opinion.

10876. I have not asked you anything with relation to the medical side of the matter. I am asking you, as a practical man, having tested hundreds of samples of malt, what you find is in practice a more or less attainable limit as regards arsenic?—With the Marsh Berzelius process as it was recommended by the Committee of the Society of Public Analysts, or preferably carried out, because of the question of solubility of arsenic, with the extract of an equivalent quantity of malt, I should say that the quantity which I have already indicated would not be reached where good fuel was used, except under abnormal conditions. But I have only a limited experience with regard to fuels, and whether larger quantities than these would be reached with other fuels, and whether larger quantities than these are still perceptible quantities I cannot say.

10877. Let us confine ourselves to your own experience?—I am confining myself to my own experience.

10878. From your experience, when you use fuel of good quality, and when you pay attention to the cleanliness of your kilns, and take all the other necessary precautions which now your experience has taught you to regard as desirable, what is the amount of arsenic which you still find that your malts contain?—I did not understand your question in that way. The malts I have been concerned with have not been reported to contain as large a quantity as I have just mentioned.

10879. What have they been reported to contain? Have they been reported to contain 1-300th of a grain per lb.?—No malt has been reported to contain that.

10880. Not so high as that?—No.

10881. Something between 1-500th and 1-300th of a grain is what they may under normal conditions contain; is that so? It is a magnitude of that order, something between 1-500th and 1-300th of a grain per lb. You would not be surprised if they contained something of that character?—I should not; and I consider, as I have indicated before, that these are intangible quantities within or very near the limits of error of estimation.

10882. But you would be surprised if they contained a much larger quantity?—Yes. I do not think they would contain a larger quantity except under exceptional circumstances.

10883. Is there anything in your procedure which is exceptional? Is there anything you do which any practical man could not equally well perform?—On the other hand, I am under considerable disadvantages in some respects.

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10884. Do you mean the disadvantages tell against you in the reduction of the amount of arsenic?—No; I should not say that. I simply refer to personal disadvantages.

10885. What I want to get from you, if I can, is, ought not your brother maltsters to conform to the same standard of efficiency that you have reached?—I am not competent to speak for my brother maltsters; I have no title to speak for them. I would rather not be pressed to speak on behalf of others, but I have every reason to believe they take as much care as I endeavour to in the matter.

10886. I will not press you. I only wanted to gather what your individual experience is, and I wished to generalise from that. I want to make use of the accumulated experience, you possess, and generalise from that with the view of finding what is a reasonable practical limitation?—I think it must depend upon the quality of the fuel which is being used more than upon any other factor, and I doubt if, say, in districts where practically only coke is available—I am fortunate not to be in such a district——

10887. Do you mean gas coke or coke of any kind?—Coke of any kind.

10888. But you yourself regard oven coke as being very much on a par with anthracite?—Some oven cokes, but I imagine there is great variation in cokes, both gas cokes and oven cokes. From analyses which I have seen I imagine that there is great difference in the character of cokes.

10889. But the differences are not wider than in the case of anthracite?—I should think that they were.

10890. That is your experience?—Not from my experience, but from published reports. I think that a limit should be imposed with great care unless it is clearly shown that that limit is necessary in the interest of the public health, because there is, so far as I am aware, no evidence that the malts which have been produced, and the beers which have been consumed in this country from time immemorial, have been other than perfectly wholesome, and because there is no evidence that the present methods of producing those malts and beers are any worse than they have been. I think that is the practical aspect of the question which the Commission ought to consider. I am sure that is how the matter will appeal to most outsiders.

10891. (*Chairman.*) You feel that it is necessary the malt should be tested for arsenic before the brewers use it?—I have seen no evidence which is convincing to my mind that any malts have contained a sufficient amount of arsenic to be injurious.

10892. But we have absolute evidence of some malt containing as much as 1-20th of a grain of arsenic per lb. or more. How are the brewers to know whether the malt contains 1-20th or 1-100th or 1-300th or less than 1-500th of a grain, unless they test it?—I think that brewers will for their own protection for a long time to come be extremely careful with regard to the malts which they use. I have not a doubt that maltsters will be equally careful with regard to the fuels which they use, and with regard to their processes of drying in the light of what has transpired.

10893. (*Professor Thorpe.*) What is to keep them up to the mark, unless it is by the imposition of something like a limit—how is the public to be made secure?

10894. (*Chairman.*) We have had some evidence of malts made since the warning was given a year and a half ago—recently made malts—containing as much as 1-10th of a grain to the lb., many containing 1-20th of a grain to the lb., and many specimens containing 1-30th, 1-40th, etc.?—I do not think such amounts ought to occur with proper methods.

10895. Of a large number examined we have many containing 1-40th, 40 containing 1-60th of a grain, 32 containing 1-100th of a grain, and so on. There must be some security against such amounts of arsenic being in the malt that is used?—Yes.

Dilution of furnace fumes with air.

10896. You told us that in some modern processes of malting a considerable proportion of the air is brought to the drying floors not through the furnace?—That is so, in almost all kilns; a large proportion.

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10897. Modern kilns?—Yes, and in almost all kilns I would go as far as to say a considerable proportion of the air that comes in contact with the malt does not come in contact with the furnace.

10898. Could you have said that two years ago as well as now?—Yes.

10899. The air that does not go through the furnace is heated how?—It dilutes the air that does go through the furnace.

10900. There is no air expressly heated for the purpose introduced in modern kilns?—There is in a certain kiln which to my knowledge has been recently built.

10901. Within this past year?—The particular kilns to which I refer have been built within the last two years.

10902. In the kilns you refer to, a considerable proportion of the air is heated and introduced to the floors, not through the furnace?—To a certain extent.

10903. To a temperature high enough for drying the malt?—In the earlier stages—when the temperature is not required to be high. I have not had actual experience of those kilns.

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10904. Have you any reason to say that most probably that malt would be less satisfactory in flavour than malt dried by fumes which have come through the floors?—I have no reason to suppose it would be less satisfactory, but I cannot say, as I have not seen the malt dried in that way. I have seen one or two samples of malt which have been dried by air alone. I have considered those malts to be somewhat deficient in what I, as a maltster, call flavour.

10905. From your own examination?—From my own tasting of them, but I have not seen a sufficient number of samples to form an opinion.

10906-10. So that there is really not any large body of evidence against drying malt solely by pure air?—I do not think there is any large body of evidence, but I think, as I have said before, there is a strong general opinion that the flavour would be different.

TWENTY-SIXTH DAY.

Friday, 31st October, 1902.

AT 1, CHAPEL PLACE.

PRESENT:

The Right Hon. Lord KELVIN (*Chairman*).

The Right Hon. Sir WILLIAM HART DYKE. | Professor THORPE.
Sir WILLIAM CHURCH. | Dr. WHITELEGGE.

Dr. BUCHANAN, *Secretary*.

Mr. H. HAMMOND SMITH, re-called; and Examined.

Mr H. H. Smith.
31 Oct. 1902.

10911. (*Chairman.*) With regard to your Report, on arsenic in various articles of food (Appendix 24) which is before us, will you in a general way tell us how the inquiries there referred to were carried out?—They were mainly carried out by direct inquiries from the manufacturers, and, in addition, as far as I could, I made use of the men who were actually working at the works to find out as much as I could about the different ways in which the manufactures were carried on. I did not confine my inquiries to a single representative of the firm. I very often went round with the manager or foreman, and consulted the chemist of the works, where there was one.

Food manufacturer may obtain B.P. quality of certain chemicals,

10912. (*Sir William Church.*) I do not know whether this is the proper time to mention it, but I would like to ask you about the use in food of Pharmacopœial preparations, as, perhaps, some of the statements in your report may be brought to the notice of the Pharmacopœial Committee of the General Medical Council. Is it the case that a good many of the manufacturers of food products rely upon getting pharmacopœial acid, pharmacopœial glycerine, and other substances, and that they do not think it necessary, if they get what are sold to them as pharmacopœial preparations, to test them any further themselves?—At a number of the works I refer to, a manufacturer—using glycerine for an example—takes the precaution of obtaining a pharmacopœial preparation, or else he orders "glycerine suitable for food purposes," and then gets supplied with glycerine which passes the test of the British Pharmacopœia. I should say that, as a rule, he is quite content not to have the glycerine tested himself. Of course, there are some who do not ask for pharmacopœial preparations, or for any other evidence of suitability for food purposes. I have lately corresponded with a medical man in Pontefract who is well acquainted with the manufacture of liquorice there. I asked him whether glycerine is used in making liquorice sweets, and he replied that it is, but that "good glycerine" would be too expensive to use for the purpose. That probably is an illustration of the use of a substance that does not conform to the pharmacopœial tests. Of some substances, such as borax, the pharmacopœial quality would hardly ever be ordered when it is required for food.

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B.P. req ments uncertain safeguar against arsenic.

10913. The question suggested by your report is whether, when pharmacopœial preparations are used, the official tests of the Pharmacopœia afford a sufficient safeguard against arsenic?—I am not quite sure that they do altogether. In some substances liable to contain arsenic, boric acid for example, arsenium is not mentioned as a contamination to be looked for. Then, again, the pharmacopœial tests require that "no arsenium" shall be present by certain tests. These tests are merely qualitative, and I am not sure how much arsenic they might pass. For example, I lately sent to Dr. McGowan a sample of acid phosphate of lime, used as a constituent of baking powder, and he reports 0·84 grain, or nearly 1 grain of arsenic per lb. in it. It is possible, though unlikely, that a merely qualitative test might not detect even as much arsenic as this.

10914. (*Professor Thorpe.*) Is acid phosphate of lime a pharmacopœial preparation?—It was bought through a chemist.

10915. Through a wholesale druggist?—Yes. I see you are right; calcium phosphate is a pharmacopœial preparation, but not the acid phosphate.

Pharmacopœial substances in foods.

10916. (*Sir William Church.*) I gather from your report that if the attention of the Pharmacopœial Committee were called to the question of arsenic in pharmacopœial substances used in foods, the chief of these substances would be sulphuric acid, hydrochloric acid, phosphoric acid, tartaric acid, citric acid, borax and boric acid, and glycerine?—Yes. Glycerine is an

exception, because in that case a quantitative limit of arsenic is fixed by a special test in the British Pharmacopœia. But it has been pointed out to me often by chemists that this test is not very stringent, and you have before you in the appendix to my report the observations which Professor Campbell Brown has made on the subject. I might add that one analytical chemist whom I saw, and who had lately been going into the question, was so much impressed with the occurrence of arsenic in glycerine that he urged that a large number of glycerines should be collected by the Commission and analysed for arsenic.

10917. (*Chairman.*) Would it be desirable that the manufacturers should be encouraged to ask for pharmacopœial glycerine, and for the pharmacopœial quality of any particular ingredient, and that if they got that they could be sure they had been efficiently tested?—I think it would be of great assistance to the manufacturers who use these substances.

10918. Would it be right, in that case, that the manufacturers should take that as being a sufficient guarantee, without testing it themselves?—It would be an additional advantage if they did test it, and where a manufacturer uses a considerable quantity of an ingredient like sulphuric acid or glycerine, I do not think he ought to neglect the precaution of testing systematically himself. In practice a golden syrup maker, using a considerable quantity of sulphuric acid, usually, and quite rightly, relies on his own testing. But in any case, what is suggested would be useful, as there would then be some form of standard to go by if the drug they were using could be required to comply with the official tests. I think the tests might, as Sir William Church suggests, be looked over again, and altered if it is found that there is any serious doubt about their significance in respect of arsenic.

10919. (*Sir William Church.*) There is another substance to which you refer in your report which I do not think is actually pharmacopœial, but which is used a great deal in the treatment of disease, namely, lanoline. It is largely used in ointments?—Yes. It was quite by accident that I came across the fact that lanoline had been used in a food preparation. It was employed at a sugar refinery to prevent the sugar boiling over too rapidly.

10920. (*Chairman.*) What is lanoline?—

10921. (*Sir William Church.*) It is a grease that is obtained from the wool of sheep, and all the sheep dips, or most of them, contain arsenic. This lanoline has been found in one or more instances to contain a high percentage of arsenic. Would you think it desirable that chemists' attention should be drawn to the possibility of arsenic in lanoline?—I should.

10922. (*Sir William Hart-Dyke.*) I suppose you wish to insist, do you not, that certain foods may contain dangerous quantities of arsenic unless great care is taken in their manufacture?—Yes.

10923. Do you think much danger is likely to arise from actual ignorance of the manufacturer as to the properties of some of the ingredients he uses?—Yes; so many of the manufacturers do not know anything of the dangers that exist. For instance, I think very few of them know of the danger of arsenic getting in by way of glycerine. It is not wilfulness on their part, it is simply that they do not know anything about it.

10924. If they knew more about these ingredients the alarm it would create would at once make them more careful?—It would make some of them more careful; but some of them are very ignorant men.

10925. Can you suggest any expedient whereby manufacturers, both those who have been long in the trade and those who have only come in lately, could be informed of the dangers which exist in these ingredients? Would it be of any use for a Government Department, upon the information which you have placed before the Commission, to issue a schedule or a list of dangerous articles and ingredients?—I do not see why those foods that may contain dangerous substances should not be scheduled, just as much as a dangerous trade in a factory is scheduled by the Home Office; or there might be a schedule of ingredients which are liable to be dangerous, and the manufacturers told of the risk they incur by using them.

10926. Do you think there is any difficulty in any careful manufacturer, who is aware of these dangers, turning out food free from arsenic?—I do not see any difficulty in their turning out food entirely free from arsenic. All these articles which are liable to introduce arsenic into food can be obtained practically arsenic free.

10927. And you do not think that in the manufactories, where these processes are going on, any material extra cost would be incurred by protecting the public?—I do not think it would cause any great increase in the cost, because the quantities used are very small.

10928. Can you tell us if any official safeguard exists to-day against the careless manufacturer, whether British or foreign, and, if so, what?—I am not an expert in legislation. So far as I understand it, there is no safeguard as to the ingredients the manufacturer uses. What safeguard there is, consists in taking samples under the Food and Drugs Act. The Commission themselves indicated in their interim report, that this control over the finished article has not in the past proved very efficient.

10929. You think, that in some cases, the safeguards, under the Food and Drugs Act, are unreliable, because they come too late, as it were?—Not only that, but I am not sure that they are quite reliable, as regards the kind of samples that are taken. Take cakes, for instance. I have never heard of cakes being examined by the public analysts. It may have been done, but I have never heard of it. The public analyst has certain things that he analyses regularly—milks, butters, peppers, and that sort of thing—and the inspector goes on, in a more or less routine way, collecting substances recognised as likely to be adulterated or diluted, in order that the vendor may make more profit; but, I doubt if many of these substances that are mentioned in this report are examined very often, or at all, for arsenic.

10930. But some foods are now being tested by the public analysts; is not that for the security of the public?—So far as arsenic is concerned, I should think the number of foods so tested is small. In the returns made by the public analysts to the Commission last year, it was evident, that just after the Manchester epidemic, a large number of foods, particularly those containing glucose, had been tested in many districts, but I do not think that public analysts are now doing much in the way of testing food for arsenic. I have had several conversations with the public analysts I have met in the course of my inquiry, and I have been rather struck by this.

10931. So far as your investigations have gone, do they lead you to think, that with regard to public analysts, a great deal more protection might be afforded, if analyses for deleterious substances were proceeded with on a much larger scale than at present?—Yes, I think it would.

10932. If the analysis of the actual food itself is not proceeded with, might not this occur, that some new method of manufacture, or some new ingredient might be used, and that might lead to danger; some new chemical process might be carried on, which would be dangerous, which might, as it were, slip in as something new, and in that case danger might arise?—Yes. It seems to me also desirable, that the manufacturer of such a food should, in some way, be liable to inspection of some sort, which would show whether there is any risk in his methods.

10933. That would tend rather to the examination of the method of manufacture, and to the analysis of every possibly injurious ingredient, rather than to analyses directed to the finished product?—Yes. I do not profess to have gone into the administrative question. I think there might be some control through the ingredients. You might, for instance, have a dangerous food schedule.

10934. With regard to imported food-stuffs—food, drinks, confectionery, and other matters—in that case, I presume, the only possible safeguard is examination and test of the finished product?—Yes, I do not see how you can do it in any other way.

10935. That is the sole protection, is it not?—I do not see any other. That question is very important. I had no idea, until I looked into it that such a large quantity of the kind of finished foods, which have been dealt with in this report, are imported into this country. For example, take these malted foods from America. I can get no information first-hand, of what these foods are malted with. Some of the agents tell me, that in America, they are always malted over anthracite. But, again, on the other hand, I have been told, with regard to a lot of the foods made in the West of America, that the anthracite would be so very expensive, that it could

Official safeguards against arsenic in ingredients.

and in finished foods, insufficient.

Possible inspection of food manufacturer.

Imported foods.

not possibly be used as a malt fuel. Then there are all the different meat foods, and the foods made from caseins, prepared by the use of different acids. They come over from America, manufactured ready for use, and you have no safeguard as to what acid they are using in America.

10936. But, with regard to all home-products and manufactures, you are strongly of opinion, that analyses should take place of each ingredient used, where it is liable to be contaminated by arsenic?—I certainly think it would be a great safeguard.

10937. You think, that should be urged upon all manufacturers?—I think it would be the greatest safeguard the public could have, if it were done.

10938. You have suggested another safeguard, namely, that there might be some schedule of all these dangerous ingredients, and that all manufacturers shall have it placed before them?—I think so, certainly.

Demand for official limits for arsenic in food:

10939. Do you think it is essential, before further action is taken in the matter, that there should be some agreement as to the quantity of arsenic, which would be enough to condemn any food as injurious to health?—I think it would be of great assistance to the manufacturer. At many of the places I have been to, I have been asked that question: "Is there going to be a standard for these things?" Of course, I said I could not say, but I think it would be of great assistance if the manufacturer knew that he must keep well below some definite limit of arsenic in his product.

10940. They want really to know, in effect, what security means?—Yes.

10941. And that would be of considerable assistance to them in dealing with all ingredients?—Yes.

10942. Tests would be applied to see that there was not above a certain quantity of poisonous matter in any ingredient?—Yes.

10943. (*Dr. Whitelegge.*) When you speak of the demands for standards from the different manufacturers, I suppose, that that was not only a demand for a standard of what was likely to be injurious to health, but a demand for a standard of the particular amount they could work to?—Yes, especially as regards ingredients. If they got more arsenic than that, it would be sufficient to condemn the article, so that they could not use it.

principle on which such limits should be fixed.

10944. There is a reference to that under "coloured foods" in your report, repeating rather what Mr. Hehner told us. I think it is rather remarkable to find that Mr. Goodfellow takes the attitude described here. He passes very considerable quantities of arsenic, presumably avoidable quantities, in consideration of the fact, that in those uses of colours which are known to him, the arsenic would be so diluted as to be harmless. I suppose, the standards which manufacturers in general are asking for, would not be standards of that sort?—The colour which Mr. Goodfellow has alluded to here, is a dry colour, which is imported into this country before it is made up into the paste, which the confectioner uses, but those were his words. He said: "I can assure you, that you will be surprised to hear what a large amount of arsenic I pass in these colours, because I know so little will eventually get into the finished article."

10945. We have your recommendation now, based on your interview with a number of manufacturers, that there should be a standard, or standards available, for manufacturers of foods?—Yes.

10946. You agree with that?—Yes.

10947. But you do not contemplate a standard of the sort adopted by Mr. Goodfellow in this instance, do you?—I have so little information about the colours, that it would be a difficult thing for me to say what the basis of a standard in colours should be. I am informed by Mr. Pronk, who belongs to a large firm of colour-makers, that it is quite possible to send out these colours, arsenic free, and that, when he is sending colours to food manufacturers, he always ascertains that those colours are arsenic free. When he finds that a colour contains arsenic, he rejects it as not being proper for food, and it is put on one side for textile manufacturers.

10948. But, would you think, that if an ingredient of food is used in a small quantity in the preparation of food, it is immaterial whether the amount of arsenic be kept down to the lowest possible limits or not?—I think it is most important that it should be kept down to the lowest possible limits, and, if possible, avoided altogether. In the colours I mentioned, the arsenic can be reduced to an extremely small proportion, or obviated altogether. Here is the whole list of colours which are used in confectionery, which are reported as arsenic-free. They are all analysed before they are sent out.

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10949. Does it not follow, that if a very small proportion be used, the additional cost (if any) to the manufacturer using it must be necessarily relatively small?—I suppose so, if he used a small quantity.

No official control over a new food manufactur

10950. (*Sir William Church.*) I should like to ask one question here. I am under the impression, that at the present time there is no Department, either governmental or municipal, that exercises any control over the private individual who sets up a manufactory of food-stuffs. He is not responsible to any one?—I believe he is not.

10951. For instance, you give an example here of Mr. Overbeck, who starts a new food, made to a large extent from malt culms. In starting that business, and putting his ware upon the market, he is not responsible to anyone, he is only responsible if his finished products are found to be deleterious, under the Food and Drugs Acts?—I believe that is so.

10952. Do you think it would be possible, that anybody, setting up a manufactory of food-stuffs, should have to give notice to any public authority?—Merely as a personal opinion, I cannot see why he should not. You protect a man from working in a dangerous trade, you impose special regulations for him; you protect a boy working in a factory, by seeing that the machinery is all properly enclosed, you protect him further by having him examined by a doctor before he is allowed to work in that factory; but any man may make any food for the man or boy to eat, and unless it is found deleterious by the public analyst, he can go on eating it until an accident occurs. That is the way the question has struck me during the time I have been inquiring into it. There are certain precautions taken, of course; for instance, the sanitary inspector finding diseased meat on sale. But there is nothing done about treacle or cakes, or anything like that. The case of Mr. Overbeck is a very good example.

Official control at factory.

10953. As a matter of practice, you have been inquiring into these things. Would it not be impossible to maintain control in any way over the production of food stuffs, because many food stuffs are produced in small quantities by private invividuals, and then placed on the market. A man who opens a factory is not really in a different position from the woman who makes a few pots of jam, which she sells on the market?—Yes; but most of the foods that we have been talking of here are made in rather large quantities in large factories. It does not follow, of course, that because they are large places their precautions are adequate. Take, for instance, a table syrup maker whom I saw the other day. He buys his glucose, and he buys the invert sugar that he makes his table syrup from. He sells some of this invert sugar as "golden syrup," and he sells another quality as "golden syrup mixed with glucose." But he has no idea where that invert sugar comes from, he has no idea what acid has been used in its manufacture; he knows nothing about his glucose. He has never had either of them analysed, and he has never had either of them tested. That manufacturer is one of the largest men in London, so that you may very possibly have an accident arising out of his ignorance of the materials that he is selling.

10954. (*Chairman.*) Where does he buy his glucose?—He gets it on the market, through merchants. He buys a large quantity at once. Take a man, again, who makes gingerbread nuts. At one place I visited they make the best gingerbread nuts with golden syrup; I know about the manufacture of this syrup, and it is a very good one. But another and cheaper golden syrup is used for the commoner article by the same manufacturer, and he knows nothing whatever of its origin or manufacture.

10955. (*Sir William Church.*) You do not think that the mere examination of the finished product, as it is turned out, is a sufficient safeguard?—I do not think it is a sufficient safeguard, unless an enormous number of foods were analysed.

10956. I gather that in your view a municipal or Government inspector should have power to enter any factory and take samples of any material which is used in the product of the factory?—I do not venture to suggest who should be the authority.

10957. Without saying who it should be, you would grant to some persons the right to enter these factories

and demand that they should be allowed to look at the books with reference to the ingredients which might be harmful?—Yes, I had that in my mind.

10958. (*Chairman.*) At present municipal inspectors under the Food and Drugs Act are entitled to enter any shops, large or small, in which food is sold?—I believe they may enter any retail shop.

10959. But there is no power for doing that in a factory?—My impression is that there is no such power.

10960. (*Sir William Church.*) Do you see any practical objection to an extension in some way of the Act that there should be some public authority—I am not saying who it should be at the present moment—who should have the right to go into a factory of food products for the purpose we are discussing?—My impression is that the large manufacturers would rather welcome it. Perhaps I am going a little too far in saying that, but they would not object to it. As to the small manufacturer, you have to deal with an ignorant man, who is using things which he had no idea were dangerous.

10960*. That would be all the more reason why you should have the power to deal with him?—Quite so.

10961. (*Professor Thorpe.*) You are suggesting, in effect, an extension of the provisions of the Food and Drugs Act to meet the case of the manufacturers, as well as the retail tradesmen. If this were done, and the machinery already set up by these Acts utilised, the authority charged with the execution of the new powers would be the local authority, subject to supervision by the Local Government Board?—Yes, that would be so.

10962. There is something in that direction already as regards margarine in the amended Margarine Act. Premises in which margarine is manufactured must be registered by the local authority, and that gives them a right of entry. Every manufacturer or wholesale dealer in margarine must keep a register, and this register must be open to the inspector of the Board of Agriculture?—I did not know that, but it is evidently an important point.

10963. (*Dr. Whitelegge.*) Margarine, of course, is a food substance and nothing else; it is often manufactured in a place where nothing but margarine is made, and there is no question about its destination for food. If you were considering foods generally, and still more if you were considering food ingredients, you would frequently have a case where the destination of the finished product might be food, or it might not. For example, take the manufacture of glucose. We have been told that there are several other destinations for glucose which have nothing to do with food whatever. I am not objecting to the suggestion of inspection, but this might be a more complicated case?—Yes; there would be many points to be worked out.

10964. (*Chairman.*) In the first section of your report, with regard to coal-tar colouring matters containing arsenic, have you, since making the report, received any information as to the quantities of arsenic found in them?—I took a sample of green colouring matter called apple green, and sent it to Dr. McGowan. He reports approximately one-twelfth of a grain of arsenic per lb. in it.

10965. Was this used for colouring food?—Yes. I took it at a confectioner's.

10966. Are there other poisonous colours used in confectionery besides those which may contain arsenic?—Some of the mineral colouring matters, I think, are poisonous, but I have not been much into the question.

(*Professor Thorpe.*) Certain coal-tar colours, which are free from arsenic, are quite as dangerous as if they contained considerable quantities of arsenic.

(*Chairman.*) And are such liable to be used by confectioners?

(*Professor Thorpe.*) Yes; that came out in evidence before the Departmental Committee on Food Preservatives and Colouring Matters.

10967. (*Dr. Whitelegge.*) It would be very convenient if we could have some evidence as to the prices of the sulphuric acid prepared in different ways. That is referred to in Section I.?—You mean the addition it might make to the price?

10968. Yes. For instance, brimstone acid, acid prepared from recovered sulphur, or by the synthetic process?—I am afraid I cannot give that straight off.

10969. Perhaps you would kindly add that. Similarly, in Section I., with regard to borax and boric acid, you speak of de-arsenicating process increasing the price £5 per ton. It would be rather useful, again, if we knew what that increase was on?—I do not know more than this; whatever the market price of the commercial boric acid is at the time, the price of the purified substance is so much more. I will give an example of the price if I can obtain it.

10970. (*Chairman.*) Can you give a summary of the chief ingredients liable to contain arsenic, which seem to require the attention of the manufacturer?—Provisionally, I would say that the chief are:—Sulphuric acid, hydrochloric acid, phosphoric acid and phosphates, tartaric and citric acids, borax and boric acid, glycerine, glucose, invert sugar, caramel, colouring matters, and malt. Ingredients requiring precautions against arsenic.

10971. In part of section 2 you deal with the risks of arsenic in golden syrup. Did not Bostock at one time make a golden syrup?—They did. I should like to refer to the visit I paid to Bostock's manufactory, where they had been trying to invert cane sugar to make table syrup. They added sulphuric acid to cane sugar, flavoured it with essences, and sent it out in tins to grocers. Luckily for the public, they failed in their process. They inverted too much, the syrup went solid, and was returned to them by the grocers. I got a sample of the returned stock, which I found on their premises, and sent it to Dr. McGowan. He at first reported that he had got such a black mirror with the syrup that he could not really estimate the amount of arsenic. I lately asked him to repeat the test, and he has taken a very small quantity, and he returns approximately one grain of arsenic per lb. of the table syrup. Bostock's table syrup.

10972. That was enough to cause wholesale poisoning?—Yes. But, luckily, nothing beyond a few specimen tins ever went on the market.

10973. (*Sir William Hart-Dyke.*) What is the date of this occurrence—was this after the Manchester scare, or quite lately?—The manufacture of this table syrup had been undertaken in 1900, not long before the detection of arsenic in the brewing sugars. I found the tins of this syrup when I visited the works on the 24th May, 1901.

10974. (*Chairman.*) A child taking a few spoonfuls of that would have a poisonous dose?—I should think it would make him very ill.

10975. Was a quantity of that syrup in stock ready to go out?—There were 14 tons in stock. It was in tins packed in small square boxes, two dozen tins in a box. They were all ready, with their labels on. Some had already been sent out, but they had been returned, because, luckily, they had got solid, and could not be sold as syrup.

10976. And through that accident it was returned to the makers?—Yes.

10977. And after it was returned, it was found to be poisonous to the extent of the amount of arsenic you have mentioned?—Yes. That is the report I have now received. After my visit to Bostock's it was all burned.

10978. (*Dr. Whitelegge.*) What were they doing with it when you found it there?—They had it in a big room in the warehouse. Mr. Williamson, who represented Messrs. Bostocks, had told the Commission that there were 700 tons of their glucose there, and I went up directly afterwards to look at this glucose, and on my way to see this at the factory, I walked through the room where the cases were.

10979. Were they not destroying it on their own initiative?—No.

10980. Nor had they examined it for arsenic?—Not until after my visit.

10981. (*Professor Thorpe.*) That means that Bostocks were practically using the same sulphuric acid for the inversion of ordinary sugar that they had been using for the manufacture of glucose?—Yes.

10982. They had been using Nicholson's acid?—Yes.

(*Chairman.*) What has become of the rest of Bostock's stock and of the firm's action against Nicholson? Disposal of Bostock's contaminated stock of glucose, &c.

(*Secretary.*) Mr. Hammond Smith has just stated that the contaminated table syrup was burned. Bostock's glucose has been sold with very stringent precautions to textile manufacturers, an undertaking being given by each person purchasing it that he proposed to use what he bought solely for the purpose of his own business and for matters unconnected with food, and that he would not part with the glucose to anybody else. Bostock's invert sugar has been sold to blacking makers with similar precautions. These steps were taken in all sales after the end of May of last year. They were really the outcome of the evidence which was given in

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the Commission by Mr. Williamson, of the correspondence which ensued between the Commission and the liquidators, and of the representations which I was instructed by the Commission to make to the Local Government Board. My colleague, Dr. Darra Mair, was sent by the Board to make local inquiry. He saw the liquidators and their representatives, and pointed out to them that the Commission and the Local Government Board were not satisfied with what had been done, and told them what precautions were essential if the stock was to be sold at all. I understand that the whole of the stock had been disposed of in the way I have said by the beginning of this year, after Dr. Mair's visit. The liquidators undertook that particulars of each separate sale should be reported to the Commission as it took place, and I have sent copies of all reports to the Local Government Board. So that we know what the destination of the stock has been, and I think we can be satisfied with the precautions to secure that none of it has had any chance to get into food since the date of Dr. Mair's visit.

10983. Is Bostock's manufactory going on still?

(*Secretary.*) No, I believe the machinery has been sold by the liquidators. With regard to the action between Bostock and Nicholson, about which you asked, I cannot give you any definite information. It has not been withdrawn.

Boron preservatives in milk.

10984. Borax and boric acid are still largely used for preserving milk and butter?—(*Witness.*) I was told at the factory of the Consolidated Borax Company that its largest use is as a preservative for bacon and ham, and that sort of thing. But notwithstanding the recommendation of the Preservatives Committee, the prosecutions lately based upon the use of preservatives in milk show that borax preservatives ar still being used. Last July, for instance, there was a prosecution for 112 grains per gallon in milk.

10985. That was a prosecution under the law as being an adulteration?—I presume so.

(*Professor Thorpe.*) These prosecutions are always brought under the same clause of the Act, namely, that a thing is not of the nature, substance, and quality demanded by the purchaser; in this case because it contained boracic acid. They are generally now successful.

10986. (*Dr. Whitelegge.*) In Section III. of your report it is said that samples of coffee have been sent to Dr. McGowan, and the same observation is made in other cases. Have you any further results of these analyses?—I have a few which have been sent in since the report was written, but I have not received the analyses of coffee yet.

10987. The results will be added when they are sent in?—Yes. I understand that a complete list of samples which Dr. McGowan is examining will be prepared when the results are complete.

Grilled foods.

10988. (*Chairman.*) With regard to the subject of food exposed to the products of combustion, and the use of fire for cooking, have you examined a mutton chop or a beefsteak which have been cooked over the fire?—I have not had any chops or steaks examined. I went to examine some of the grills in the big grill rooms in London. The mode of construction of the fireplace led me to think that while chops and steaks received the heat from the coke, the actual product of combustion was drawn through the back of the grill and passed up the chimney.

10989. With the old method of cooking mutton chops and beef steaks over the fire, if there was arsenic in the fuel one would think it would come in contact with the steak. Have any experiments been made as to this?—No, I do not think so. I have made none.

10990. Do you think there is reason to believe that arsenic to a perceptible degree could get into a beef steak cooked over an ordinary fire?—Not to any dangerous degree. I would refer to the amount of arsenic which we obtained on bloaters. The figures are given in Section III. These bloaters were exposed for a fairly long time.

10991. Exposed to the fumes?—Yes.

10992. I see the greatest amount of arsenic is about 1-140th grain to a pound of skin?—Yes, after they had been 18 hours exposed to the fumes of coke. So there is not a great deal of arsenic gets on.

10993. That perhaps answers my question sufficiently?—The food was really exposed to the fumes coming directly from the fire, which was in a brazier containing coke, placed directly under the bloaters. The bloaters are hung on rods above the coke, raised tier on tier. When I took the samples I always took some samples from the bottom of the tier closest to the coke, and some from the top tier to the highest elevation. But you even see in the lowest tier there is not a great quantity of arsenic deposited on the bloater.

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10994. As the bloater is cool, if it is put into the fumes for the purpose of being dried it is then more liable to get a deposit of arsenic than if it was hot?—The bloater is put on wet, and, I suppose, any arsenic which came off the coke would on that account be more liable to be deposited on the bloater.

Arsenic in chicory.

10995. (*Dr. Whitelegge.*) Do you know if the attention of any public body abroad has been given to the danger of arsenic in chicory?—I do not think so. It has never been mentioned to me by any chicory roasters whom I have seen in England. I have some works on the preparation of chicory abroad, but I cannot find anything about arsenic in them.

10996. There is no attempt at public control of it?—As far as I am aware, none.

Fattening fowls with arsenic.

10997. (*Sir William Church.*) I should like to ask a question with regard to the table in Section IV. which is not quite clear. I think it should have something added. These fowls when bought were stated to weigh 14oz. When the experiments began they weighed 26oz.?—Just so. They were kept until they were ready for fattening.

10998. I think it will be just as well to put that in. This fact is also remarkable, although it is not a large enough experiment to draw deductions from. Two of the fowls which were fed on arsenic, Nos. 4 and 5, if you will add up the totals, increased in weight very much in the same ratio as the two which were not fed on arsenic. But another two, Nos. 3 and 6, both cockerels and fed with arsenic, increased much faster than the control birds. I think it would make the table complete if the total weights at the time they were killed were added at the end?—I will see that that is done. The curious part as to what you mention is that the birds got on to what you might call a killing weight very much faster when they were taking arsenic than when they were not. I tried it again, though not so fully, this year. I kept a lot of chickens on arsenic this year, and it is very curious how quickly they got to their killing weight. They got to it a month sooner.

10999. Exactly. The arsenic birds increased more rapidly—I do not say much more rapidly, as the results seem very irregular?—They seemed to get rapidly up to a certain weight, and afterwards not to increase, whereas the control birds went on increasing.

Arsenic in fowls' feathers.

11000. The really important thing about your experiments is that the arsenic appeared ultimately in the feathers and not in the flesh?—Yes, and they showed, too, that fowls can tolerate arsenic if the fattener administers it. Mr. Tegetmeier, when I saw him, would not have it, but my poultry friends all have a suspicion of it. It is given at the end to increase their weight very rapidly. The birds are got to their full weight quicker.

11001. (*Chairman.*) That is interesting information as to the elimination of arsenic by the feathers. As a practical matter, do any of the producers of fowls get tempted to use arsenic by knowing that the fowls increase in weight?—I think they must know it, but my information is very meagre on the point, because directly you mention the word arsenic you get no more information. I was talking to one of these fowl fatteners on the subject about this time last year, and he would not tell me whether he used anything but ordinary fat and milk. Directly I asked him, "Do you use any chemical additions to your food?" he began to talk about how many eggs his fowls would lay in a year. He would talk on anything except the subject of fowl fattening.

11002. Was this a professional man?—Yes, a professional fowl fattener.

11003. Do you think he used arsenic?—I am unable to say. He would not tell me.

11004. Did you ask him?—At last I had to put it plainly. He said, "No, I do not know anything about it." But I did not believe him, because I am certain, from one or two things I have heard, that arsenic is used. But I cannot get the information direct. I tried to get some of their food, but I did not manage it.

11005. Did you make the acquaintance of any other people in the trade?—Yes, I tried to get it through some friends, who are also poultry breeders. I got them to go down and try to see these people who fatten fowls in Surrey, but they could not get to know; they would not tell them anything.

11006. (*Dr. Whitelegge.*) In what part of the feathers was the arsenic found? In what part of a given feather?—I do not know. I think the whole of the feather was taken for analysis.

11007. In the case of a hair there is some reason to believe that it is not distributed over the whole length, but that it goes into the growing part. There may be some unequal distribution in the case of a feather corresponding to that?—There might be, but I have no experiments as to that.

11008. (*Chairman.*) Can you make any addition to what you say on the subject of enamels in Section 4?—Since I wrote that report I have received a little more information on the subject from Mr. Albert Smith, who is an analytical chemist in the North of London. He discovered for himself, while using some enamelled pots for chemical purposes, that the solution he took out of those pots contained arsenic. He then tried boiling plain water with some soda in it in the pots, and he found he got arsenic in his solution. He then tried whether the constituent parts of the solutions which he put into the pots had been free from arsenic, and he found that they were free. Then he analysed the enamel of the pots, and found that in one instance he got 0·46 per cent. of arsenious oxide in the enamel, and in another instance he had 2·03 of arsenious oxide per cent. in the enamel. The point is of some importance, as these experiments rather show that the food cooked in an enamelled pot containing arsenic in its enamel might become contaminated by arsenic possibly to a dangerous extent.

11009. You say he boiled some water in the enamelled pot with soda?—Yes.

11010. And he took arsenic out of the enamel?—Yes.

11011. Would pure water take arsenic out of the enamel?—I do not know. I may say that Mr. Albert Smith thought that the pots were a cheap Belgian ware. I have made some inquiries among English manufacturers of enamel, and they tell me that for cooking utensils they never use arsenic now, and that they thought I might take it as a matter of certainty that no arsenic is used in the manufacture of enamelled hardware in England for cooking purposes.

11012. (*Dr. Whitelegge.*) It is within the experience of my Department that the use of arsenic in the manufacture of enamelled metal hollow-ware has decreased very much. We placed the manufacturers under regulations to obviate industrial poisoning, and in order to escape the regulations they gave up the use of arsenic?—That was exactly what they told me. They said it was to avoid being placed in the category of the dangerous trades that they gave it up, although they might possibly make a better enamel with it.

11013. (*Professor Thorpe.*) Is there any reason to believe that enamel which is better or cheaper by virtue of containing arsenic is allowed to come into this country from Belgium or Germany or other places in competition with the English manufacturer?—I have only the statement of Mr. Albert Smith.

11014. There is no check on the importation of these things at present?—I believe not.

11015. (*Sir William Church.*) Does this enamel come in as enamel, or is it that the hardware comes in already enamelled?—No; in the articles in question the enamelled pots themselves were imported. It is possible, of course, that enamel may be imported as such, but I do not know if this is the case.

11016. (*Chairman.*) Have any analyses for arsenic been made of the enamels taken from pots?—I have got together a large number of samples of both English and foreign hardware for that purpose, and they are ready for examination by Dr. McGowan.

(*Dr. Whitelegge.*) Dr. Thorpe has made a certain number of analyses for the Home Office, and these results can be supplied if the Commission wish to have them.

(*Chairman.*) Is arsenic found in them?

(*Professor Thorpe.*) Very little now. It is the rarest possible thing that we find arsenic in them now.

(*Sir William Hart Dyke.*) And negligible when you do find it.

(*Professor Thorpe.*) Practically so.

(*Dr. Whitelegge.*) Would it be difficult to obtain some cheap Belgian enamelled goods?

(*Witness.*) The difficulty with enamelled hardware is to get anything authentic as to their origin. They are sent out without a trade-mark, and you cannot tell exactly where they are made. These enamelled pots that Mr. Albert Smith spoke of had no distinctive mark on them. I have been told that there is an enamel made in America which contains arsenic, and is sold as mottled enamel, but I have no particulars with regard to it.

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Difficulty in identifying origin of ware.

11017. (*Dr. Whitelegge.*) It comes over as enamel?—No; the ware about which I have been told comes over finished.

11018. (*Chairman.*) The statement of Mr. Cochrane mentioned in your report is rather remarkable. Is it probable that similar experience has occurred to others?—Mr. Cochrane is a retired ironmonger, and he came and volunteered that statement to me. He suggested that enamelled hardware should be examined for arsenic on account of a wholesale case of poisoning that occurred, as he believed, from some hardware he had sold. He was asked to supply a hotel in London with some copper saucepans in a hurry. They had a rush of people in, and as he had no copper saucepans in stock, he said, "If you will use these enamelled saucepans for to-night, I will send you the copper ones in the morning." They used them, and everybody in the hotel who had food out of these enamelled saucepans was taken ill.

11019. (*Sir William Church.*) Was that the occurrence at Lincoln's Inn?—No; an earlier case than that. This was several years ago, at a hotel in Bryanston Street.

11020. (*Dr. Whitelegge.*) Did he say enough about the nature of the illness to make it point to arsenic? There are other things than arsenic which might conceivably be dissolved from the enamel?—No; I cannot say that it was fully proved on the facts he gave me.

11021. (*Chairman.*) Were the enamels that Mr. Cochrane described English enamels?—These pans were supplied to the hotel some years ago, and they were English enamels. But it was some years ago when they were made, and at that time I believe they did use arsenic in English enamels.

11022. Does the risk of arsenic getting into food only hold when the article is new?—That is what might perhaps be expected—that the newer it is, if there is arsenic in it, the more likely you are to get it out.

11023. Would it be safe after it had been used and washed a great many times? Might not a little extra heat at some time make the enamel scale off?—I am not prepared to say, but I should suppose it would come off more readily when it was first used than afterwards.

11024. (*Chairman.*) In this summary at the end of your report, what does "brewed temperance beverages" mean? Does that mean fermented beverages?—I meant brewed temperance beverages, such as ginger-beer and non-alcoholic beer.

"Brewed temperance beverages."

11025. It is really a fermenting?—Yes; the drinks to which I refer here were brewed and fermented. In relation to that I may say that some of these brewed temperance beverages are brewed from brewers' invert sugar. The beer that they brew up in Manchester, called "Best British Beer," for instance, is brewed from invert sugar. They told me they did not use malt, but malt substitute; but when I went to see what it was, it was simply brewers' invert sugar.

11026. Was that a temperance beverage, or was it a beer?—It was a temperance beverage. The amount of alcohol was kept below the regulation amount. Of course, an essence of hops was added to it to make it taste like beer.

11027. (*Professor Thorpe.*) I may make a remark here which bears on the discussion we had on a previous section. In reference to what is said here, that the manufacturers use precautions to secure freedom of tartaric acid and citric acid from lead, that was due to the action of local authorities, or, rather, the public analysts, in bringing actions into court in the case of mineral water and soda water contaminated with small quantities of lead. It was when the manufacturers found they were liable under the Food and Drugs Acts, and some of them were rather heavily fined, that they stipulated that the materials they used should be pure?—Yes; no doubt that was the case.

TWENTY-SEVENTH DAY.

Friday, 21st November 1902.

AT 1, CHAPEL PLACE.

PRESENT:

The Right Hon. Sir WILLIAM HART-DYKE (*Chairman*).

Sir WILLIAM CHURCH. | Dr. WHITELEGGE.

Dr. BUCHANAN, *Secretary*.

Mr. C. LYLE, called; and Examined.

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11028. (*Chairman.*) You are connected with the firm of Messrs. Abram Lyle and Sons, sugar refiners and golden syrup makers?—Yes.

11029. I believe your business is in London?—Yes.

11030. How many years have you been established there?—We started building our factory in 1881; we started to manufacture sugar in 1883.

11031. I suppose you may be said to be in a large way of business?—Yes, ours is the second largest in the kingdom. Mr. Tate's, I think, is the largest.

11032. You necessarily use, do you not, sulphuric acid in the manufacture of your golden syrup?—Yes. If you are referring simply to golden syrup I may say that I am by far the largest maker of golden syrup in the kingdom; I was referring before to general sugar work.

Always known that golden syrup liable to be arsenical.

11033. I believe that from the very commencement of your business you have been aware of the liability of golden syrup to become dangerously contaminated with arsenic if proper care is not taken; you have been alive to that from the very first?—Yes.

11034. And you have been conducting your business on the principle that, with this danger attending it, you must use the utmost care with regard to the materials used, in order that the manufacture shall be free from arsenic?—Yes, from the very first we have tested every carboy we ever had for arsenic ourselves, besides having bought it as brimstone-made acid.

Precautions taken.

11035. I think Mr. Hammond Smith in his evidence has given us some details of the precautions that you have been in the habit of using to safeguard yourselves?—Yes, he was good enough to show me what he had said about us, and it is quite correct.

Sulphuric acid must contain less than 2 parts per million.

11036. With regard to the amount of contamination, have you any difficulty in obtaining a sulphuric acid containing no more arsenic than one part in a million, that would be about 1-140th of a grain per lb. I think that is the limit of your test?—We subject it to a test which reveals one part in a million, and sometimes, but not frequently, we get it to show one part in 500,000. If it does that we reject it—we do not reject it, but we caution the manufacturer. If it were more than one in half-a-million we should certainly reject it. But from brimstone-made acid we never have had more than 1 in 500,000; we have rarely had it as much as that.

11037. At any rate, you have never gone above that amount of arsenic in the acid?—That is so.

11038. You are confident about that?—Quite.

11039. You also use phosphoric acid, do you not?—Yes, to a very small extent.

11040. But you do use it at times?—Yes.

11041. Are you obliged to use it, or is it a matter of choice?—It is not a necessity, but it is part of our process to use it; we think there is an advantage in using it.

Phosphoric acid also.

11042. Have you any difficulty in obtaining phosphoric acid with similar freedom from arsenic?—No, we have no difficulty, but I think phosphoric acid more frequently comes nearer the limit.

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11043. You think there is a distinction between the two?—I think that phosphoric acid is a little more apt to contain arsenic.

11044. It is more liable to contain arsenic than the sulphuric acid?—Yes, I think so. Still it may be got, and we do get it free—not absolutely free, but to show not more than the quantity I mentioned, 1 in 500,000.

Mere guarantee with acid insufficient.

11045. With regard to the application of tests, would you consider it essential that you should make tests in both cases, whether in sulphuric acid or in phosphoric acid, totally irrespective of any guarantee that was given by the firm from whom you purchased the article?—Yes.

11046. You would depend solely on a guarantee?—No, certainly not.

11047. In the conduct of your business have you been in the habit of applying tests?—Always.

11048. Totally irrespective of any guarantee given you?—Yes, we trusted to our own tests, not to the guarantee, although we had the guarantee as well.

Brimstone acid used.

11049. Do you have a guarantee in every case?—We have a guarantee that it is made from brimstone. We could have bought guaranteed acid which had been made from pyrites and treated to remove arsenic, but we did not think that as safe as buying brimstone acid.

11050. You thought that safer?—Yes. The other when carefully prepared is all right and very pure, but there is always the liability to some error or accident.

Tests applied.

11051-2. With regard to your manufacture in general, do you know if there is any general standard of purity for sulphuric acid or phosphoric acid which can be said to be applied by all manufacturers of the class of products made by your firm?—There is none recognised. Up to the time of this arsenic scare people were content if the Marsh test alone was used. If no arsenic was revealed by the Marsh test it was considered to be sufficiently delicate without going to the Berzelius in addition. If the product showed nothing by the Marsh test it was considered sufficiently free for all practical purposes.

11053. What has happened since this unfortunate occurrence at Manchester?—We still use the Marsh test in the old way, but besides that we have the Marsh-Berzelius, with which we check the other.

11054. You superadd the other in every case?—Yes, in every case of phosphoric acid and sulphuric acid. I may say that we have tested the Marsh-Berzelius against the Marsh, and it is from those tests that we find we can detect from the Marsh test alone one part in one million, whereas by the Marsh-Berzelius we can detect one part in 20 millions. In fact, with regard to the Marsh-Berzelius test as applied by chemists nowadays, I do not know whether there would be any limit.

Question of official limit for sulphuric acid used in food.

11055. Do you think there would be any advantage in having a kind of fixed standard of purity as regards these two substances, sulphuric acid and phosphoric acid, which would give an indication to all those engaged in manufactures such as yours that anything below that standard should not be used?—There would be no harm done in fixing a limit if it was a sufficiently

wide one. We have always been careful not to exceed one part in 500,000, but if you look at the figures that I give in my memorandum I think you could very safely allow a great deal more.

11056. Can you tell the Commission, generally speaking, whether what has been termed the Manchester scare has had any effect on trades and manufactures such as yours with regard to making the manufacturers more careful in adopting a more stringent test?—I do not know about my neighbours, but I should think that naturally everyone would look into the question, as I have done. Although we did it before, we went even more narrowly into it since the scare, and I presume others have done the same thing. It is almost two years since the scare began, and I have been working in every direction to see whether the minutest traces can come in or be eliminated, and I do not see that we have altered or can alter one iota from what we were doing before.

11057. In fact, you have not changed the system you have always adopted in your business on account of the scare?—No. I suppose we have taken a few more precautions in the manner of making sure that no carboy could possibly be taken that had not been analysed; in that respect we have taken a few more precautions.

11058. As far as you are concerned, you do not think that, assuming the effect of this very serious occurrence in Manchester wore off by degrees, the consumer might suffer through some carelessness or laxity in the conduct of these manufactures?—Unless you got another careless manufacturer such as you had then. That is always possible; but so far as we are concerned the consumer would not suffer.

11059. At all events in your case it would not obtain?—Not in the slightest.

11060. Would you have any objection if it were in the power of an officer of a Government department, such as the Local Government Board, to visit your works?—An inspector does come down now and take samples of our invert sugar. We make a little invert for brewers, but we do a very small trade.

11061. Is that for the purpose of detecting any dangerous ingredients, or for Revenue purposes?—No; he gets it tested for arsenic.

11062. It is not for Revenue purposes?—I think it is entirely for arsenic, because it is only since the scare that he has done so.

11063. (*Dr. Whitelegge.*) Is it not since the sugar duty came on?—No, it is disconnected with that altogether. He comes down and takes a sample of what he finds in stock at our place, and says that he is going to test it for arsenic, and the next time he comes round he says: "I found that that sample was free," or "I found most minute traces," or something like that.

11064. (*Chairman.*) Can you make any suggestion to the Commission as to the source of arsenic occasionally found in West Indian brown sugar?—There are three or four possible sources. The likeliest I should say would be the use of chloride of tin. In order to get that special yellow colour the West Indian manufacturers largely use chloride of tin. It has the property of giving it the special colour that they want.

11065. You think that through that medium arsenic might easily be conveyed?—I think it is a very probable cause. We never use chloride of tin, and I have never tested it for arsenic; but I should think that was a very probable source. Tin is very often associated with arsenic; it is found associated with it.

11066. I suppose you cannot tell us what percentage of arsenic per pound might possibly be found in brown sugar?—I have tested a great many samples in one way or another, and I have found in one or two exceptional cases somewhere about 1-60th grain per pound.

11067. Would you say that that was an uncommon result?—Yes, I think that is uncommon.

11068. You think that is excessive, and avoidable?—Yes, decidedly so. It is more than one would look for, and I was surprised to find it.

11069. But you have actually found that quantity per pound?—Yes; but, on the other hand, I have found other West India sugars quite free.

11070. You have sent us a memorandum with regard to the possibility of fixing a limit to be applied equally to all food and drink. You say, "If a limit is applied equally to all food and drink it would greatly favour the brewer, who has been the cause of all the trouble, as against the manufacturer of articles of much smaller possible consumption, and which have been hitherto above suspicion." Do you mean to say that if a limit were fixed you would wish to differentiate between food and beer according to the amount consumed?—Yes, and not only between food and beer, but between one food and another. I suppose that a man could take more beer than he could take of any one food. I put in my statement that a man might consume two gallons—I do not think that is extravagant in some cases.

11071. I have known cases where more was consumed than that?—I wanted to state it moderately. But if the limit were the same on a gallon of beer as it was on a pound of golden syrup—I take that because it is my own article—a man would be allowed to get from the brewer a far greater dose of arsenic than from me. Why should the brewer be put on better terms than I am? He has been the culprit in this case, and why should he be more leniently dealt with than other manufacturers who have not hitherto done any harm? That is my point of view.

should allow for character of the food.

11072. You do not think, surely, it would be a satisfactory outcome of the deliberations of a Commission like this if they were to go into a grave matter affecting consumers of food or drink on such a basis as that?—To differentiate?

11073. Yes?—Why not? Take extremes—take pepper or salt. You could not poison a man with arsenic in salt unless you had some extravagant quantity in it.

11074. (*Dr. Whitelegge.*) If I follow you clearly, your argument is that we ought to fix a very high limit in some foods, not by reason of the difficulty of keeping it out, but by reason of the small proportion in which it is used?—Yes; I contrasted golden syrup and beer. If you have the same limit for a pound of golden syrup as for a gallon of beer a man might get far more arsenic from the brewer than he would get from me.

11075. (*Chairman.*) Do not you think it would be a far safer principle to adopt to secure, as far as human ingenuity and skill can devise, that all articles of food or drink should be as free from arsenic as possible?—But there is no such thing as freedom from arsenic.

11076. As free as possible?—You must define what is "as free as possible." Then I want to point out this also, that supposing, for the sake of argument, you fix a very narrow limit, such as 1-140th grain per pound for all food, and supposing a pound of sugar was put in a grocer's window on such a day as this, how long would it take for 1-140th grain of arsenic to deposit in the smuts and smoke that are here to-day? Then a manufacturer would be found liable, and his goodwill destroyed through a thing that he had no control over. It would not take many hours in such an atmosphere as we have this morning to get 1-140th of a grain deposited in the smuts.

Food might get arsenic from dust.

11077. (*Sir William Church.*) I understand that you have been manufacturing golden syrup for about 20 years?—We began to manufacture golden syrup in 1884.

Precautions before 1900.

11078. What did you understand by brimstone acid at that time?—Acid made from brimstone. We meant native brimstone, not sulphur from refuse works such as gas works.

11079. Is not comparatively little now made from Sicilian or natural brimstone?—I hardly think so. Every pound we get is made from Sicilian brimstone. Here is our last invoice. (*Handed in.*)

11080. Is it not the case that in the sulphuric acid trade a great deal of acid is sold as brimstone acid which is made from the refuse of gas works?—It may be so; but it is not in our case, because, as you see, it is native Sicilian brimstone. Since we started we have only dealt with two firms. Gibbs and Co., whose premises are two doors from us, were one of the firms, and I have gone in and seen the brimstone myself.

11081. Pearce is the other?—Yes. I have letter after letter from Pearce, saying that he guarantees it, and assuring us that it is made from brimstone, and that no pyrites is used.

11082. Is C.O.V. a particular brand?—No, that is concentrated oil of vitriol.

11083. From the very commencement of your making golden syrup you have had your acid tested?—Always.

11084. Do you keep your own analytical chemists?—We have a large staff of analytical chemists.

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11085. And at that time, in 1884, did you specially test it for arsenic?—We always tested it for arsenic, and also tested it for specific gravity and purity, to see that we were getting the right quality.

11086. Even at that early stage you specifically tested it for arsenic?—Yes, we did.

11087. I suppose you just sampled a consignment, you did not test each separate carboy?—We took a sample of a great many carboys in each consignment. As a rule they came in lots of 30 carboys. Each load would be sampled, perhaps six or eight carboys in the load indiscriminately.

11088. And even at that early date you found very little contamination with arsenic?—Very little.

11089. Have you found, or have your chemists found, any greater difficulty in applying the Marsh-Berzelius test than in applying the Marsh test?—It is a much more difficult test to carry out well and scientifically.

11090. But have you found any practical difficulty?—No, we have found no practical difficulty if we have expert chemists; but it takes a long time, and it takes the services of two or three chemists regularly. We have two chemists who have been at this subject ever since this took place.

11091. Have your chemists ever found any difficulty in getting pure re-agents to work with?—Yes, there was some difficulty at first in getting them absolutely pure, but I think these difficulties are now got over.

11092. Do you mean at first, 20 years ago, or lately?—No. About 20 years ago we were only working with the Marsh test, and there was no difficulty in getting re-agents sufficiently delicate for that work; but when you come to the Marsh-Berzelius, it is more difficult.

11093. But still they have been able to satisfy themselves that they have got pure re-agents?—Yes, that has all been quite got over.

11094. The result of their work is singularly favourable as compared with other evidence we have had given us?—I think most chemists will now say that they can get clean re-agents.

Rejection of acid because of arsenic.

11095. How frequently, in the course of these years, have you found specimens of acid which have exceeded those limits of arsenic which you have mentioned—one part in one million and one part in 500,000?—I think we have never returned any sulphuric acid within my recollection. But on one or two occasions we have returned phosphoric acid.

11096. And, notwithstanding that constant result, you have not relaxed your vigilance at all?—Not a bit, no, never.

11097. I may take it from you that, so far as your own experience goes, there is no difficulty in manufacturers on a large scale making use of the Marsh-Berzelius test?—There is only the difficulty of a considerable expense attached to it. If one were to test all one's products regularly by the Marsh-Berzelius test to see what they contained, I suppose we should need four or five experienced chemists doing nothing else but that.

Expense of testing by Marsh-Berzelius.

11098. It takes a longer time; but I do not see quite what is the greater difficulty in using it than in using the ordinary Marsh test?—We have an experienced man with all the appliances that we can think of at work, and he cannot get through more than ten analyses per day. If he had to test everything in my factory during its different stages, and the final product, he could not do it all in a day; I am referring to his testing the final products of our own manufacture.

Objection to constant testing of finished products.

11099. (*Chairman.*) You mean he could not keep pace with the different processes going on?—Yes. We make ten or twelve different qualities, and there would be, perhaps, ten or twelve different boilings a day in each of those qualities.

11100. (*Sir William Church.*) But he would only have to test the materials from which it was made?—If there were a very narrow limit on the finished article, we could not afford to let any go out that was not tested.

11101. What other possible source of arsenic besides that which is in the materials could come into your manufacture?—I do not know of any other possible source, but still it would be so serious a business for any manufacturer to find the narrow limit exceeded that he could not afford to do it. To be safe he would have to test every lot himself. I certainly should. Consider: one bad lot going out that exceeded, say, 1-140th of a grain would ruin him—his trade, goodwill, and name would be gone.

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11102. But how is that 1-140th to get in if you are using perfectly pure materials? If you test your acid, and that is free, and does not contain a trace of arsenic, and if your sugar is free, and does not contain a trace of arsenic, how do you suppose the arsenic will get in unless you suggest it comes from the atmosphere?—It might come from the atmosphere, and it might also come from iron rust. Suppose some of your sugars got contaminated by iron rust, which is a very probable thing, you would have it in the iron, and you would exceed that limit right away.

11103. Rust which gets into the sugar after it has been inverted?—Yes, and even after it is finally manufactured.

11104. Through passing through iron pipes?—It may be a rusted vessel, or a rusted pipe, or something of that kind. You are dealing with such a minute quantity that you must look out for every possible source. The quantity is so small that you can get it from the atmosphere, from smuts, and you can get it from iron rust, or you might get it from any dusty, dirty contamination.

11105. Therefore your contention is that it is impossible to get it absolutely pure?—Yes; at any rate, it is impossible to guarantee it unless you made the limit sufficiently wide to cover all those contingencies.

11106. You are rather pressing now for some standard limit to be fixed. I was inquiring rather with a view to its being excluded altogether, and I rather gather that in your trade you think that is almost an impossibility?—At present it is an impossibility for any manufacturer to guarantee any article, I do not care what it is, free from arsenic in the chemical sense. Such a thing does not exist.

11107. To go back again for one moment to the practical working of analyses, it appears to me that if your material is analysed, and is found free from arsenic when you commence to use it, that, practically speaking, there is no danger of any sensible amount of arsenic getting in in the course of manufacture?—But there lies the whole crux of the question: what is a sensible quantity? You would never get anything free from arsenic. If you say there must be none, then it is impossible.

11108. Granted that we do not get absolute purity, surely what I say is the case, that so long as you take care that your materials are free from arsenic——?—When did I say that they are free from arsenic? They are never free.

11109. You have told us that all your sulphuric acid and all your sugar gives you no more than traces; you have told us to-day that sometimes you find none?—I would not say none—practically none.

11110. You said none, not practically none?—I do not think I said none.

11111. Yes, you said that in Jamaica sugar you found none?—I was speaking broadly there; but in the chemical sense you cannot say that anything is free from arsenic; and that is one reason, and my main reason, for saying in my memorandum that I want a limit fixed where a manufacturer can say it is free. Just at present no man can say it is free.

11112. You think that a limit of 1 in 500,000 need not be exceeded?—In acids, do you mean—in sulphuric acid?

11113. In your finished article?—Certainly not.

Does not get 1 part arsenic in a million of golden syrup.

11114. One in a million, perhaps?—Yes; I never do exceed it, but I want a broad, wide limit, so as to avoid the necessity of having to test everything.

11115. But my point now is that I should like to know what you, as a practical manufacturer, think would be a working limit. Would one in two millions be practicable; or would one in one million be impracticable?—One in one million would be practicable, I think, for golden syrup—talking of that only. One in one million is quite practicable, but still I think it would compel me to analyse everything. I never have got anything approaching that in my syrups; but still, if that were the law that that limit must not be exceeded, to protect myself I must analyse everything.

But official limit should be much more lax.

11116. Then at the present time you do not analyse everything?—We analyse a great many here and there, but we do not analyse everything.

11117. Do you analyse all your finished products?—We analyse a great many of them, not all of them. We take surprise tests here and there, just at odd intervals, and test those.

11118. I suppose that before this arsenic scare—that is to say, previous to the last two or three years—the main object of the chemist you kept was to see that you produced a good finished article rather than to examine your materials?—Both. We buy all sugar upon analysis, and we therefore had a large staff. All the sugar trade is done upon analysis.

11119. But that is an analysis for the quality of the sugar?—Yes, but that compelled us to keep a chemist. When we did that, we also supervised all our departments with chemists, and we supervised all the acids, and so on, that we bought.

11120. The commercial chemists, if I may use such a term—that is to say, the chemists employed by commercial firms for their various purposes—although most competent chemists for those purposes, are not very competent chemists very often for analytical purposes, are they?—I can only speak for my head man. He is a Bachelor of Science.

11121. We understand a little behind that. The chemist who is engaged in one particular line of research, such as the commercial value of materials, does not have his mind directed to the analysis of impurities in the same way as a chemist who is employed rather in analysing materials for impurities?—I differ from you. I possess a fair amount of chemical knowledge myself, and from the very beginning, when we began to use acid, I consulted my chemist and said: "Now, before we use sulphuric acid what must we watch for?" He naturally said: "We must look for arsenic," and we did look for arsenic. We looked for lead; in fact, we looked for every possible contamination. We have examined, not once, but a hundred times, all round for all other things besides arsenic. We have by no means confined our attention to arsenic; we looked for everything that was likely to be injurious.

11122. That is a very wide term—that you looked for everything; you looked for the likely things?—We know we are doing a process that might bring in such contaminations.

11123. Any chemist would know that if he is using sulphuric acid he would be likely to meet with lead and arsenic?—Yes.

11124. Did you look for anything else?—Yes, I have searched again and again for all the different metals.

11125. Before this scare?—Yes, long before that.

11126. Before this Commission sat did you ever look for selenium?—No*.

11127. Can you tell me of anything that you looked for besides lead and arsenic?—Yes. I have looked for oxalic acid and copper—at the moment that is all I can think of. We looked more to acids attacking our vessels than anything else. We have looked for zinc. Then when we knew there were special processes going on on the Continent we have looked for traces of these special things. We have also looked for barium.

11128. (*Dr. Whitelegge.*) I suppose you make all these analyses for two objects generally, for the safety of the public and for the reputation of your firm?—Yes.

11129. Would you think it safe to rely upon analysis of the final product only, without attempting any check analysis of the ingredients?—As a matter of fact, we begin by ascertaining that our ingredients are safe first.

11130. I follow that; but do you regard it as essential to look at the ingredients as well as the finished produce?—If one carefully looked at the finished product that would be sufficient, I think; but I think it would be the wrong end to begin upon, because if you found your product was bad you would not let it go out upon the market. Prevention is better than cure.

11131. In your own interests it is better to look at the ingredients?—Yes.

11132. Are your books kept in such a way that if by some mischance the check analyses made by your chemist were omitted, and if it were found that your finished product contained a considerable quantity of arsenic, you could bring that home to a particular lot of sulphuric acid and to a particular guarantee that it was made with brimstone acid?—We could do that now, to a particular lot, but we could not always have done it.

11133. The system you now use would enable you to identify, in the event of any mischance in the finished product, the particular lot of ingredients that it was made from?—Yes.

11134. What would be your position in regard to the vendor of the acid if you had a complaint from your customers that arsenic had been found? I am assuming now that it missed detection in the tests—I do not say it is possible—I am putting a hypothetical case to you. I am assuming that if a particular lot of golden syrup containing arsenic were sent out, you would be able to identify it with the particular lot of acid. What would your position be in relation to the vendor of that acid?—I think I should have a claim upon him—I should expect that I had. It is more a legal question, which I am happy to say has never cropped up.

Effect of guarantee with acid.

11135. I only wanted to know your opinion. You think that the guarantee amounts to something more than the power of returning the acid if it does not comply with that guarantee?—Yes, I think he is liable for the consequences.

11136. Do you consider that the system of check analyses is equally necessary in small works?—Certainly.

11137. Is there any difficulty in carrying it out in small works which does not arise in the case of a large firm like yours?—Only the expense.

11138. Is the expense greater relatively?—I should say it would be, decidedly.

11139. Are their consignments fewer or smaller?—The consignments would be smaller, and then a small works naturally could not maintain a large staff of chemists so well.

11140. There would be other work for the expert chemist to do in addition to that?—Yes, there would be such things to do in our case that there would not be in small works.

Question of official inspection of factory.

11141. You told us that an inspector visited your works occasionally and took samples which were tested for arsenic. Can you tell us whether that was an inspector of the Board of Inland Revenue?—I think it is an Excise inspector—yes, it is from the Excise authorities.

11142. I suppose your works are never visited by the inspectors of the local authority, the District Council?—With regard to this question?

11143. In any respect?—Only if we are putting up new buildings. They supervise the erection of new buildings.

11144. You are never visited for the purpose of the Sale of Food and Drugs Act?—No, I have never seen them.

11145. Would you consider it inconvenient if powers were given to local authorities to visit manufactories of food products and take samples?—It would be no great inconvenience if he simply limited himself to taking samples.

11146. You would not object to that?—I would not like it. I have nothing to hide. When I say that we are never visited for that purpose, I know, of course that samples are bought in grocers' shops.

11147. I am asking you whether you think it would be inconvenient that the officers of the local authority who now have power under the Sale of Food and Drugs Act to buy samples in shops, should have the same power to test the articles which are in bulk at the manufactories?—No, I would not look upon it as a great inconvenience, but I would be rather averse to it all the same.

Use of chloride of tin to colour sugar.

11148. You have mentioned chloride of tin. Is that substance used in your works?—No.

11149. Can you tell us in what sort of proportion it is used?—No, I could only give you a very rough guess—it would be little more than a guess from memory, because we never have used it.

11150. Is it used to stain the sugar, or what?—They strive to get a yellow colour, a bloom, as they call it, and that is obtained by adding the tin to the sugar.

* Since giving this answer my chemist has recalled to me that he did search specially for selenium, but found none.

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11151. Is the tin removed afterwards?—It passes through in the centrifugal machine, and goes into the syrups.

11152. And remains in the syrups?—Yes.

11153. And no steps are taken to remove it from the syrups?—Finally these are molasses, which are distilled into rum.

Official limit of arsenic should be lax.

11154. There is one figure given in your memorandum which I think is rather important. You say: "This test reveals the presence of one part of arsenic in 1,000,000, and no sulphuric acid was ever used which showed more than one part in 500,000. As we use only one per cent. of acid to sugar, our very worst case would not therefore show more than 1-7142nd of a grain per lb. from this source." I do not want to go over the ground again, but I understand you to say that although from your sulphuric acid, which you regard as an important point of danger, and which you take every means to safeguard, you get not more than 1-7142nd of a grain per lb., still you think that for the finished product a standard of 1-140th would be too rigid, having regard to other possibilities?—Not that I think it will be there. I have never, as I have said, seen anything like 1-140th in the finished product, but I think if you make a limit, particularly if it is to be a penal limit, it would compel analysis of everything.

11155. Of every final product?—Yes, before we sent it out. *Mr. C. Lyle.* 21 Nov. 1902.

11156. (*Chairman.*) I suppose you are strongly of opinion, that the precautions which you use are necessary, generally speaking, for the trade?—Yes.

11157. Do you not think that there should be a careful analysis of each ingredient used, and of the finished product, not only for trade purposes to secure you against loss after you have prepared a material, but for the safety of the consumer?—Not necessarily of the finished product. I do not analyse every finished product; I do it, as I have said, occasionally here and there; but that is what I want to avoid having to do.

Security depends on care with ingredients.

11158. You think security is best obtained by analysing at the initial stage of the manufacture, and dealing with each ingredient?—Yes.

11159. Will you kindly tell us, roughly speaking, how many chemists are constantly employed in your business?—We must have a staff of from 25 to 30. When I talk of chemists, I ought to say that we have, for instance, one laboratory that is worked by girls. They, of course, are not trained chemists; they are trained to that special department and to the routine work.

11160. But they are part of the analytical staff in a sense?—Yes; we have an analytical staff of from 25 to 30.

Mr. R. Howell, called; and Examined.

Mr. R. Howell.

11161. (*Chairman.*) I believe you represent a London firm, do you not?—Yes, Messrs. Stevenson and Howell.

11162. Are you as large as any firm in your line of business?—Very nearly as large as any; perhaps there is one larger than ourselves.

Chemicals for food and drug purposes.

11163. Is the chief bulk of your business done for food purposes or for chemical and drugs?—The chief bulk of our business is for food purposes—indirectly for food purposes. Our business lies very largely with mineral water manufacturers and wholesale confectioners, supplying such things as essences, citric and tartaric acids—which we do not manufacture, but which we deal in very largely—and essential oils.

11164. You not only manufacture, but you purchase to sell again?—Yes. We manufacture principally essences and essential oils.

11165. You deal with a variety of chemical substances which are liable to contain arsenic in an impure state?—Yes—which were liable, I should say rather than are liable. I should think there is a good deal of difference in the last 12 months.

Greater precautions against arsenic lately.

11166. Has the difference in the last 12 months arisen on account of extra precautions taken since the occurrence in Manchester?—Yes, I think so very largely. In the first place, the tests for arsenic are very much more stringent than they used to be, and I think that now there is a demand for arsenic free substances, the manufacturers of such substances have found themselves fully equal to fulfil that demand.

11167. I suppose you deal in phosphoric acid?—I cannot say that we do not deal in phosphoric acid, because we do, but we do not supply it for dietetic purposes. If a man wants to use phosphoric acid for acidifying lemonade or aerated waters, we decline to supply him, and always have, not because we were afraid of its containing arsenic, but because we consider that the proper acidifying agent or material for aerated waters, and for other waters, is natural fruit acid.

11168. You think the process is wrong?—I may say that citric and tartaric acids are the acids which are generally used for the purposes.

11169. Do you supply phosphates of soda and other phosphates?—Phosphate of soda to a very small extent; I should hardly like to say that we supplied that for dietetic purposes.

11170. Boric acid?—That is supplied as a preservative generally.

11171. Sulphuric acid?—That is used for generating carbonic acid gas.

11172. Tartaric acid?—That is used for various purposes, chiefly as an acidifying agent in aerated waters and confectionery.

11173. And glycerine?—With regard to glycerine, until I had some conversation with Mr. Hammond Smith I was under the impression that glycerine was not used to any very great extent in confectionery, but he has told me that it is used very largely in cake making and biscuit making. We supply it to confectioners; they do not tell us what they are using it for, but I presume they use it for that purpose. As a rule, when any firm of confectioners use anything special in that way they keep it to themselves; they are not anxious to tell the people who supply them with it what they use it for. *Mr. R. Howell.*

No knowledge of purpose for which confectioners use glycerine.

11174. You were not generally aware as a trader, that it was used for this purpose until Mr. Hammond Smith informed you?—No. I think I may say that I was not aware what they used it for. I do not know that I ever gave the matter serious consideration. With us it is not a very big article; we do not sell large quantities to confectioners.

Nature of precautions.

11175. Do you take any steps with regard to these various substances to secure their freedom from arsenic?—Yes. In the first place we get guarantees from the manufacturers, and, in the second place, we never make a contract on a sample for the supply of such an article as glycerine without submitting it for analysis to the firm of Helbing and Passmore, whom you may know. We do not even trust to our own chemist. If we make a contract we send a sample of everything round to this firm of analysts, with whom we have an arrangement, and they make an examination, and hand us a certificate.

11176. When you purchase any ingredients of this type, or when those who purchase from you do so, you take a sample out of the lot that is sent to you, and have it tested?—First of all we have that sample submitted. The makers, or the agents, or whoever it may be, that are selling to us submit a sample to us, which represents the bulk.

11177. In the same way they forward you a sample of the material?—That is so.

Tests made by firm.

11178. Then the professional gentlemen supply you with a report as to whether it is free from arsenic or not?—Yes.

11179. That is the way you conduct your business?—Yes.

11180. When you talk of chemists, are they analytical chemists, or chemists with whom you are trading generally?—They are chemists engaged in conducting manufacturing operations in our place, and others who are making investigations with a view to finding out any improvements or anything new in our line of business.

11181. You mentioned whom you relied on to test in regard to freedom from arsenic; but in addition to that is there in any sense an analytical staff at your works?—

Occasionally we rely upon our staff of chemists for examinations, not particularly with regard to arsenic, but with regard to lead in citric acid and tartaric acid, etc.

11182. And with regard to experiments connected with the trade?—Yes. But they are in no way safeguards to us. We do not regard them as safeguards to us for the purity of the goods. We regard Helbing and Passmore in that light—the analysts that we employ.

11183. Your sole reliance is on that one analysis in each case of a sample?—Are you speaking about the glycerine?

11184. Yes?—With regard to glycerine, I should say we get the guarantee from the manufacturers in the first place, which is a certain amount of safeguard; then in addition to that we submit the sample to Helbing and Passmore.

11185. But you rely in regard to all these substances more on your analytical test than you rely on a guarantee?—Yes, certainly. I should mention specifically three articles—glycerine, sulphuric acid, and glucose—which are the only three articles that I can find that we deal in that are likely to be really injurious, which are actually used as articles of food. It seems to me there is a good deal of difference between articles used for food purposes and articles not used for food purposes.

11186. Could you tell the Commission of any case in which you have given up trading with any particular firm with which you had been dealing in any of these substances, such as sulphuric acid, tartaric acid, or citric acid, on account of the detection of arsenic?—No.

11187. How many years have you been in this business?—Since 1881.

11188. And during that time, apart altogether from the occurrence at Manchester through the arsenical poisoning of beer, have you had any cause for alarm on analyses?—Never.

11189. I mean alarm, of course, in regard to the quantity of arsenic found in any substance?—No, never.

11190. Has your firm ever adopted anything like a limit of arsenic which you would consider admissible or otherwise for food purposes?—You could not compare a limit of arsenic in boracic acid or metasulphite of potash, which is largely used in brewing, and a limit of arsenic in glucose. There is no comparison between the two that I can see. For instance, we will say for the sake of argument that we find metasulphite of potash contains 1-12th of a grain of arsenic to the pound, which is a large proportion. Three ounces of that metasulphite of potash are used to the barrel of beer. That means in actual figures—I have not the figures in my head—something like 1-26,000th part of a grain of arsenic to the pint of beer, which is less than the Gutzeit or the Marsh test can detect. That has always seemed to me to be a very important point in connection with chemicals as applied to foods or drinks, so that we really find it rather difficult to establish a standard. The only standard that I know of is the B.P. standard, which, curiously enough, is only actually fixed in glycerine. In glycerine I believe the Gutzeit test is applied, and that really fixes, according to our calculations, the limit of arsenic in glycerine at about 1-200th part of a grain to the pound.

11191. You wish to make a kind of proportion sum of it—that where the quantity of a material which is used in the food is infinitesimal compared with others, that in that case you would allow with perfect confidence a larger amount of arsenic?—I would not, because I have never come across a sample of metasulphite of potash containing that proportion of arsenic, and if it did we should have rejected it. We would reject boracic acid containing that proportion of arsenic. At the same time it seems to me that up to 1-12th of a grain it really is not very material.

11192. Still, you would allow that what we should endeavour to obtain would be that every ingredient that is used, either in your trade or in any other, should be as free from arsenic as possible?—Most certainly.

11193. The point you have urged was merely incidental, was it not?—Yes. I do not wish to urge any point which means that arsenic should be passed in any way at all. I do not think it should be; I do not think it is necessary. I think that if a fixed limit of arsenic is insisted upon that it is easily arrived at.

11194. You were rather urging this—that there was a degree of danger in a much larger sense in one chemical than in another?—Yes; you would not compare glycerine, which is used more or less as an article of food, I believe, in biscuits and cakes, and also is very often given to children as medicine in equal parts with honey, with such things as boric acid, metasulphites, and sulphites generally which are used in breweries.

Guarantees given to customers, if asked for.

11195. Are you often asked by your customers for a guarantee, or do you give a guarantee without being asked?—We never give a guarantee without being asked, but we give guarantees for those who ask for them. We are asked for guarantees for all sorts of absurd things, which, of course, we are able to give.

11196. What special form do these guarantees take?—Guaranteed free from arsenic.

11197. Not free from any deleterious substance?—The citric and tartaric acids are guaranteed commercially free from lead.

11198. Do you usually sell to middlemen?—No, we sell generally direct to the manufacturers—very seldom to the middlemen at all.

11199. And you know generally for what specific purpose your chemicals are required?—Yes, as a rule we know. We give recipes with most of the things to show the manufacturer how they are to be used in the case of essences and citric and tartaric acids.

Chemical substances liable to be arsenical sold under misleading names.

11200. Do you happen to know of any instance where chemical substances liable to contain arsenic, such as phosphoric acid, are sold under special trade names?—Yes, a great many.

11201. And thus the purchaser might have a wrong idea given him of the nature of the substances he is using. Can you give us any information with regard to that point?—I think there are any number of cases. For instance, there is "phospho-citric acid," which is sold to mineral-water makers. I do not know that that is a misleading name altogether, because it consists of about 96 per cent. of phosphoric acid and about 4 per cent. of citric acid. Then there is another acid which is sold in Manchester called "liquid tartaric acid," which, I believe, contains no tartaric acid at all, or, if so, only the same proportion as the citric acid in "phospho-citric" acid. Then there are such things as "cremaline" and "cream of tartar substitute"—any number of them. There is scarcely a house in the trade that has not fallen more or less into the temptation of making extra profit by selling these substitutes. There is another substitute which is largely used as a substitute for cream of tartar, bisulphate of potash.

11202. Can you point to any remedy for this state of things?—Yes; make it illegal to sell a chemical substance under a wrong name—any article sold for food under a wrong name or designation. The buyer does not know what it is—the buyer hardly knows what cream of tartar means.

Form of guarantee with colours.

11203. I have your catalogue here. What is the meaning of the analysts' statement on p. 32 when he speaks of colours as being "perfectly harmless for confectionery and for articles of food"—does that refer to absence from arsenic?—That is Mr. William Jago's report you are referring to, I presume? That refers to freedom from arsenic. It is his opinion that these colours are suitable for dietetic purposes.

11204. Does this statement apply to mineral colours such as bole armenia, which we found contained up to 1 grain of arsenic per pound?—No; it applies particularly to the colours which are enumerated in that list.

11205. Only to those?—Yes, practically to the series of aniline colours which are sold. Though aniline colours used to contain a considerable proportion of arsenic 10 years ago, one never, or very rarely, meets with arsenic at all in aniline colours at the present day, because the processes have improved so much.

11206. There has been a great improvement as regards the preparation of all these dyes?—Yes, a very great improvement.

11207. (*Sir William Church.*) I should like to ask some questions about these aniline colours, because I am under the impression that many of the aniline dyes are injurious, quite apart from their containing arsenic?—Yes, that is what the certificate particularly applies to.

11208. "For any aniline colours such as are certified harmless"?—Yes.

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11209. Therefore yours are submitted to Mr. Jago, so that the public may be protected from any which are likely to be hurtful?—Exactly.

11210. I imagine from your list that you supply brewers on a large scale?—Not on a large scale; we do supply brewers, but it is a very minor branch of our business.

11211. You are not yourselves manufacturers of tartaric acid?—No, we are not.

11212. You buy your tartaric acid, I understand, on guarantees?—Yes, we buy our tartaric acid on guarantees. We buy the best tartaric acid that we know of. As a matter of fact, we deal for tartaric acid and citric acid with a firm you will know very well, John Bennett Lawes.

11213. They are the largest makers?—Yes.

11214. As far as tartaric acid goes, you are middlemen? Yes, as far as a great many of those things are concerned.

11215. Do you analyse it before you send it out yourselves?—We are constantly sending it over to Helbing and Passmore for examination, and other different makes of tartaric acid and citric acid, both for our own and for our customers' protection.

11216. With regard to citric acid, the same remark applies—you are not manufacturers?—No, we are not manufacturers.

11217. In the same way you test that before you send it out again?—I do not mean that we are always testing citric acid for arsenic. We cannot do that. We rely to a very great extent upon Messrs. Lawes' guarantee, and upon their reputation.

Tartaric acid rejected, but on account of lead.

11218. Have you often had to reject any tartaric acid?—Not from Lawes, but we have had to reject tartaric acid on account of its containing lead.

11219. But not arsenic?—Not arsenic, never. I think I may safely say that we have never found arsenic in either tartaric acid or citric acid.

11220. What quantity would have caused you to reject a consignment of tartaric or citric acid containing arsenic?—It is rather difficult for me to say.

11221. Do you pass it if it contains any lead?—I have never seen a tartaric acid or citric acid which is chemically free from lead, but so long as it passes the British Pharmacopœia test we consider we are safe in sending it out. The British Pharmacopœia is rather like the family Bible to the manufacturing chemist: I do not know whether it is as reliable.

11222. You do not sell large quantities of boric acid?—No, not large quantities, but we sell a reasonable amount.

11223. With regard to the other borax preparations which you sell, they are used very largely as preservatives in food, I suppose?—Yes, we sell a certain quantity of them, but not large quantities.

11224. Those you make yourselves?—No, we do not make borax or boric acid. We buy them on guarantee and analysis.

11225. I suppose you do not make glycoline and those sort of things?—That is a patent thing, which to a great extent contains borax?—I am afraid I do not know it at all.

11226. It is a thing which is largely sold. What is the largest quantity of arsenic that you have passed in meta-sulphite of potash? You have told us that you did not think 1-12th of a grain in a barrel would hurt?—If it contained 1-1,000th part of a grain to the lb.—that is the limit of detection, is it not, of the Gutzeit test or the Marsh test?—we should consider that was not free from arsenic.

11227. Then directly either the Gutzeit test or the Marsh test, not the Marsh-Berzelius——?—The Marsh-Berzelius, I mean.

11228. Directly they gave indications of arsenic you would reject it?—Yes, most certainly.

Purity attainable.

11229. Then it is feasible to get it pure?—Yes, I think it is quite feasible. It seems to me, as a working manufacturer or dealer or whatever I may be in connection with the chemical trade, that it all hinges upon the sulphuric acid, and that now it is quite easy to get sulphuric acid automatically free from arsenic, if one may use the term, with this new process—the catalytic process—the whole thing seems to me to turn upon that.

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11230. (*Dr. Whitelegge.*) For the most part you buy and sell, do you not?—Yes, as far as articles likely to contain arsenic are concerned.

11231. You make certain things, I believe?—As far as the things you gentlemen are particularly interested in are concerned, I should say we buy and sell most of them, as far as those things which are liable to contain arsenic are concerned.

11232. Food ingredients generally?—Yes.

11233. You store in bulk, I suppose?—Yes.

11234. When articles are stored, are they covered? We have been told that whatever precautions may be taken as regards ingredients, that arsenic deposited by soot from the air, and so on, has to be borne in mind as a material cause of contamination by arsenic. Is that your experience? And does your method of storage confirm that?—I will tell you what our method of storage is. Such things as boric acid, tartaric acid, and citric acid are put into large standard casks with a closely-fitting cover, and supposing 1 cwt. is wanted, the cover is taken off and the other cask in which the goods are to be sent out is filled, and then the cover is put on again.

11235. Do you store anything loosely?—Well, of course when the contents of a cask which may start by holding 10 cwts. are reduced to 2 cwts., it is more or less, loosely stored.

11236. (*Chairman.*) But it is still covered?—Yes.

11236*. (*Dr. Whitelegge.*) Have you any experience in that way tending to show that there is material contamination from the air and smoke?—No, no experience whatever.

11237. Are your works visited by the Excise for any purpose?—Yes, we have an Excise officer there almost daily.

11238. On what footing does he come to you?—We ship large quantities of essences to various parts of the world—essences for making aerated waters, for flavouring aerated waters, and confectionery purposes.

11239. It is a question of rebate?—Yes. We hold certain licenses from the Inland Revenue—compounders' licenses, and dealers' licenses, and so on.

11240. But you are not visited by the officers of the local authority—the District Council officers?—No, unless we make ourselves a nuisance, or anything of that sort.

No objection to samples being taken officially at works.

11241. They do not come to you for the purpose of the Sale of Food and Drugs Act, and take samples?—No.

11242. Would you object to their doing that?—Not in the least.

11243. You said that on ethical grounds you would not supply phosphoric acid to aerated water manufacturers?—Yes.

11244. Do you supply it for food purposes at all?—We supply it, we quote it in our price list as a matter of fact, and I think we make a particular remark. We say, "Phosphoric acid—concentrated, commercial, frequently sold under various misleading names as a substitute for tartaric and citric acids." We do that so that we may let the buyers know that these substitutes practically are phosphoric acid. I think we do the same thing with regard to bi-sulphate of potash, which we quote as "largely sold under very misleading titles as a substitute for cream of tartar."

11245. But you do sell it?—Yes. With regard to potash bi-sulphate, I do not think we ever sell any at all.

11246. It goes to your customer, who may use it for food?—We do not know. Phosphoric acid we sell largely to chemists and druggists, whose business is very varied. We do a considerable amount of business with blacking manufacturers and ink manufacturers, and we do not know in the least what particular buyers are coming for a certain article, so we put everything into the list.

Manufacturers' guarantee relied on in some cases.

11247. That being so, what is your practice with regard to phosphoric acid? Is that tested by your chemists for arsenic?—No, as a matter of fact, we rely upon the manufacturers for that.

11248. Then you obtain a guarantee with it?—Yes.

11249. A guarantee of freedom from arsenic?—I happen to have had two guarantees quite recently from two manufacturers—absolute freedom from arsenic.

11250. Do you sell Bole Armenia?—Yes, we do quote it.

11251. Can you say whether you make it?—No.

11252. It is a natural product more or less, is it not?—Yes.

11253. What is your practice with regard to arsenic in that?—It never occurred to me that it contained arsenic in any way.

11254. It is not examined by your chemist?—Not at all.

11255. I am afraid we have had evidence tending to show that it is necessary to look for it?—We must look to that at once—that is a drysalter's article rather.*

11256. Is acid phosphate of lime one of your articles?—No, we do not sell that rather on principle, because that is used as a substitute for baking powder. We sell ordinary calcic phosphate, but that is more a pharmacopœial article.

* Since my attendance I have drawn a sample of Armenian bole from our stock, and sent it to Messrs. Helbing and Passmore for analysis. I have since received their report that it is quite free from arsenic.

11257. And if you sell that, it would be examined for arsenic in the ordinary way?—Yes; but the demand for that is very small. *Mr. R. Howell.* 21 Nov. 1902.

11258. (*Sir William Church.*) With regard to phosphate of soda, do you sell it largely to confectioners as an ingredient of baking powders at times?—I can hardly tell you what use phosphate of soda is put to. I know that we buy at times perhaps a cwt.—it is a very small thing indeed, and it disappears gradually in the course of business. I do not know what is done with it.

11259. That is a substance which has been found occasionally very highly arsenical?—Of course, one knows of one very bad case of it indeed; but it is free from arsenic now, because I sent a sample of it over quite recently to Helbing and Passmore for examination, and we consider that when we get a certificate from people like Helbing and Passmore we are practically safe. I should say, if you would not mind my making a suggestion about that, that Dr. Passmore, of Helbing and Passmore, will give you more information on the subject of arsenic than any other chemist in London. I look upon him as quite the very best authority on any matter of that sort. I think his evidence would be very valuable to you if you would care to have it.

Mr. C. Overbeck, called; and Examined.

11260. (*Chairman.*) I believe you come from Grimsby, do you not?—Yes. *Mr. C. Overbeck.*

11261. You invented a food called "Carnos"?—Yes.

11262. Can you briefly describe to the Commission what it is?—It is a meat extract substitute in which all the component parts are dissolved, and in which there is no solid matter. It is a meat extract not produced, as it were, from meat. I was led to the idea by finding out that yeast contained a meat basis, which is really the stimulant part of meat extracts; and it contained also a large quantity of hydro-carbons of a very nutritive nature, produced from glycogen, and so forth, which could be utilised as a food, and which would alone supply the form of an extract of meat, and at the same time would supply other constituents that meat extracts lack. The extract is rich in phosphate of potash, and consequently is in that way also valuable. The great point with me was this. I wished to make a meat extract which should be devoid of the shortcomings of extracts made from meat; I wished also to be able in doing so to make an extract not by chemical means, but as much as possible by natural means, in order that I could say that the substance was a natural substance and not a chemical product, as far as it would be possible to do so; and I think it bears out in its analysis what I claimed at the time for it. It may be condensed to a very thick syrup or practically solid. It is perfectly clear, having been filtered. Consequently, all substances in it are readily assimilable, and require no further digestion. The chemical part of the question is, of course, very complicated indeed, because in malt culms we have a lot of nitrogenous substances of a very nutritive character. One can give but a small quantity as food, because it is too feeding and too heating. These products are, I found, by digestion at a moderate temperature of, say, 120° or 130° F., considerably altered by the formation of peptones, and by the albuminoids being made more soluble. The peptase in the culms is also capable of acting upon certain nitrogenous matters in the yeast itself, when once the yeast cells have been broken up. Consequently, albuminoids which may be insoluble and not obtainable out of the yeast as such, on boiling and after having been converted, would become soluble and valuable and could be utilised. At the same time, the culms contain similar carbo-hydrate compounds, such as yeast contains, and the combination of the two would form a natural extract containing meat basis, carbo-hydrates, phosphates—all strengthening and fattening materials—as well as stimulants naturally produced without the actual employment of any meat.

11263. When did you first commence producing this nutritive form of food?—It is getting on for three years now; something like that. I should think it is not quite three years.

11264. You commenced to make it before this occurrence at Manchester with regard to the arsenical poisoning?—Yes.

11265. Was "Carnos" sold in any quantity before this occurrence?—I cannot say in any quantity, because the company formed was a private company made up of friends of mine, to exploit and try the substance. *Mr. C. Overbeck.*

11266. A kind of syndicate?—Yes, with a very limited capital, and consequently we were not able to put it on the market on a large scale. We had to work with it on a small scale, and carefully to try and test the feeling and general taste of the public before risking any more upon it.

11267. Can you give us any indication as to how much was sold—what would a week's sale amount to; do you know the largest sale you had?—The largest sale would be perhaps not more than 40lbs., I should think; but in the summer months, as with all the other extracts, it fell off completely.

11268. I suppose you are aware of the evidence that has been given before this Commission with regard to the possible contamination of malt culms with arsenic?—I am aware of the possible presence of arsenic in malt culms.

11269. Had you any suspicion of such a thing before the sittings of this Commission?—No, only since the scare started in connection with the beer. I then at once thought of the culms.

11270. Have you taken any precaution to ascertain by analysis whether any of these ingredients that you used contain arsenic?—After it became public knowledge that these ingredients might contain it, or did contain it, I at once analysed the materials, and found the traces one would expect in these particular materials. At that time, not knowing how much might have been in any past brew, in order to prevent danger of any sort I recalled everything I possibly could, lest in any past brew, before I knew anything about it, there should be any contamination which might have occurred, and which might be deleterious.

11271. You called in all the ingredients you could possibly reach?—I called in all the "Carnos" made according to our books that I could possibly reach. Of course, it is quite certain that here and there a little may have been left; it was impossible to actually find out from the bottles, but we sent notices to all our customers that we were sending an improved extract out, and we should be glad to have their present samples back again. Samples called in on account of arsenic.

11272. Have you taken any steps since to analyse the finished material of "Carnos"?—Whilst I was connected with "Carnos"—it is in liquidation at present—I examined several different lots. I took every precaution, chemically and mechanically, that suggested itself to me during the process which could possibly eliminate it.

11273. Can you give the Commission any results of the analyses?—The figures that I got varied very much; they were generally somewhere about 1-30th of a grain per lb. Then I considered that when one comes to think that in one ounce there are four large cupfuls of Arsenic in Carnos.

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"Carnos," that that would work out at an exceedingly small amount in the substance. Of course, with all these things, it is very difficult to know what limit will be fixed as necessary with these different foods, and therefore I worked to eliminate everything I possibly could, bringing it down so low that I thought that, whatever inquiry would be made, the amount of substance that could possibly be taken at one time would be taken into account, and it would be seen that everything had been done to make it perfectly safe, and that it was so low as to be perfectly harmless; because really absolute freedom from arsenic in any commodity is simply a matter of the quantity taken for analysis.

11274. I have some analyses here of a sample of "Carnos" purchased through a local druggist in July, 1901, which contained 1-25th of a grain of arsenic per lb.; I have another sample given to Mr. Hammond Smith by yourself on November 9th, 1901, which produced 1-25th of a grain per lb., and another sample purchased through a local druggist on May 14th, 1902, which is said to have produced 1-6th of a grain of arsenic per lb. Those are serious quantities, are they not?—The 1-6th of a grain to me is a surprise, because that is very high indeed compared with any of the results I got when I made examinations while I was in connection with Carnos. I never allowed anything to pass at that. But even a sample containing 1-6th of a grain per lb. would work out at 1-300th of a grain in a cup of "Carnos," so that, even taken at that high figure—and I never had any "Carnos" which approached that figure—it would not be excessive on account of the amount of the substance used. Still, it is not at all a figure such as I came across at any time. I can only account for it in one way, namely, that it came from a brew made while the company was in liquidation, which I have not seen. That is all I can say about it. But there has been practically no sale for the last year since it has been in the hands of the liquidator.

Company in liquidation.

11275. Is it likely that the sale of "Carnos" will cease altogether?—I am very sorry to say I am afraid it will. It is a very great pity, from the value of the material itself.

11276. Assuming that the company were not in liquidation, and that the sale was likely to increase, and there was likely to be a large consumption of it, surely some greater precautions ought to be taken as regards the materials used?—Certainly. Not a single material would be passed, and not a single batch of substance made would ever be passed, which would contain more than, say, 1-25th of a grain, which I think you will agree is very low.

Would pass 1-25th grain per lb.

11277. (*Sir William Church.*) What directed your attention in the first instance to this manufacture?—It is now quite 14 or 15 years ago since I first experimented in that direction, long before any of these yeast foods were known. It is about 15 years since I approached Armour's, in America, and asked them if they would consider it as a valuable substitute to mix with their meat extract. The correspondence went on for a certain time, but the business relations did not come off.

11278. It has been in your mind for some years. I do not know what your profession has been; I rather wanted to know how your mind became directed to it?—I am a brewer's chemist, but before I became a brewer's chemist I was at the University, with the idea of merely remaining at the University and merely studying. That was altered, and consequently I did far more chemistry than was ever required for the business.

11279. You have answered my question; I see now how your mind became directed to the subject. Of course, you had a certain amount of special knowledge as a brewer's chemist?—Yes; I had the commodity under my eyes. I saw there was a dreadful waste of the most valuable materials that we had in the brewery.

11280. Did it ever occur to you that there might be a possibility of danger in the use of those substances?—Not before.

11281. Although you are a brewer's chemist, you did not realise the existence of arsenic in malt?—Nobody did, I think. Of all the chemists I have met I have never heard of one who had guessed it.

11282. Before you put this food upon the market, did you take any steps to satisfy yourself of the wholesomeness of it?—When I made the substance itself, I tried it repeatedly on myself. I tried it also on animals, on dogs and cats, and it was so like meat that it struck me it would become a splendid substitute for it. I thought if both cats and dogs were deceived in taste and flavour, and it agreed with them, and that they evidently liked it——

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11283. I understand that you experimented on your own person, and experimented also on the persons of dogs and cats, and, finding it had no bad effect, you then thought you were justified in putting it on the market?—Yes.

11284. You took right and proper precautions. Do you think it is right that anybody should bring out a food stuff without his showing some authority that he is a person who is likely to have taken proper precautions that the food stuff he brings out is not harmful?—I should look upon that question in this sense. I had experimented so long, and knew the constituents of the stuff so well——

11285. I am asking you altogether apart from that. You have told me that you did take steps—that you experimented on cats and dogs, and yourself; but I ask you whether, as an inventor and a manufacturer, you think it is right that anybody should be able—as I believe they can at the present time—to bring out and advertise and place upon the market a food stuff without their being responsible to anybody that the food is not harmful?—I should say that they ought to have found out for themselves that it was not harmful before they put it upon the market, and that there was some value in it. The public is not easily misled to believe that a substance is valuable as a food product unless it is so.

11286. As a manufacturer, would you have any objection to manufacturers coming under the Sale of Food and Drugs Act, and samples being taken out of your factory?—I should not have the slightest objection to anything that could lend itself, in the first place, to satisfy any authority that everything was made from the purest materials obtainable, and in the cleanest and best manner, and also such an authority that I should know also would and could give the greatest help in saying that the process could not be improved upon. Anything that will improve the process, and help the public and the substance itself honestly and straightforwardly made, I do not think there is any objection to whatever. As it is, our works are always open to the Medical Officer of Health of the place, and have been from the very beginning.

No objection to samples being taken at factory.

11287. But not for the purpose of examination of the material you are producing, but to see that it is carried on under proper conditions?—Yes. I mean any local precaution that I could take to satisfy everybody that I was doing my best to make food in the best possible way. When Mr. Hammond Smith came, I was only too pleased to show him over and explain everything I possibly could in order that everybody should understand exactly the true bearings of the whole process.

11288. (*Dr. Whitelegge.*) When you were making the "Carnos," did you obtain your yeast and culms from manufacturers?—Yes.

11289. From brewers and maltsters?—I obtained my yeast from my own brewery.

11290. Are you a brewer?—I am manager of a brewery.

11291. Was any analysis made at any time for arsenic of the yeast that was used in manufacturing "Carnos"?—Yes, I found that the slightest trace of arsenic had been found in yeast. By the bye, I think I may say that the arsenic in yeast that has been given is not exactly inside the yeast cell, but may be superficial to some extent, for these reasons: When I found there was a certain amount of arsenic in the yeast, I used pressed yeast. It struck me at once, if that is so, I expect that yeast, being really more animal than plant, I could help it considerably by washing the yeast. In the original process I simply pressed my yeast and used it; after I had pressed my yeast dry, I passed a weak solution of soda water through the yeast, and washed it through in order that any superficial contamination on the yeast cells that might occur or might be present should be eliminated, and I really do think that that generally lowered the arsenic in the yeast itself, although one must never forget that no two batches of yeast from any brewery come out alike.

11292. At all events, you tested the yeast, and you would reject any that was found to contain a considerable quantity of arsenic?—Yes.

11293. When did you begin to do that?—The date I cannot give; I began it when I was associated with the

company—directly the arsenical poisoning scare commenced, when my eyes were opened to the fact that arsenic might be present in the yeast.

11294. Did you reject the yeast of any brew?—I never had to reject one; I never had any trouble in my own brewery with arsenic.

11295. What test did you use?—The hydrogen tests.

11296. The Marsh test?—Yes.

11297. With regard to the malt culms, did they come from your own works too?—No. I used really pale-malt culms. I wished the culms to be as pale as I possibly could get them on account of colouring matter, and so that the "Carnos" should not be traced to culms. Consequently I got them from a large maltster locally. I got their palest culms—that is to say, culms least fired. I found there were traces of arsenic discoverable upon culms in my original process where I digested the yeast and the culms together in the mash tun with water at the proper temperature. So that I now wash my culms first and press them. That I found helped considerably.

11298. Then you tested for arsenic?—Yes.

11299. Using the same process?—Yes.

11300. And if you found arsenic did you reject it?—I did not reject it then, because I have still further methods of eliminating it afterwards. When I found that in one or two batches the arsenic was too high I did not use any of the brew whatever.

11301. What do you mean by saying "too high"—what sort of standard?—When I found the darkening was considerable, then I knew it would be too high; I did not use any of it; it was thrown absolutely away.

11302. Otherwise what did you do with it?—After that I tried sulphuretted hydrogen solution in glycerine. In part of the process, when the warm liquid is being pumped up preparatory to boiling, this was mixed with it. In the original process I once filtered the finished product. Now I do not; I put the sulphuretted hydrogen in. The liquid was well boiled to 1060 degrees specific gravity, and then filtered, because I knew that I filtered the whole of the sulphide of arsenic together with the insoluble albuminoids off.

11303. But did you verify that by examining the filtrates?—Yes; I found out that I eliminated a lot of it, because I never got it so high after I used that process. Then I knew perfectly well that sulphuretted hydrogen must separate it, as I used a double fine filter. Some time after I did that I used polished copper plates, and I boiled them in the liquid to see if any darkening took place, because the "Carnos" is of an acid nature—there are various acids naturally produced in it, not chemically added. I found that when the plates were boiled they darkened considerably, but after the sulphuretted hydrogen had been added I could boil my plates for two or three hours and they did not perceptibly darken at all. Then I condensed my liquid in a vacuum condenser, and I bought another filter press and filtered it once more, and the perfectly clear filtrate that I obtained without a shade of precipitate gave the 1-30th of a grain, and then I thought I had gone as far as anybody could to eliminate it.

11304. But how did you get the 1-30th of a grain? Is it arsenic that has escaped the sulphuretted hydrogen, or what?—The quantity was so minute that I let it pass at that; I made no research to find if it was sulphide of arsenic—it must be sulphide of arsenic, because I always use a large excess of sulphuretted hydrogen; and I boiled it for so long that it was immaterial to me whether there was a small or large quantity in it.

11305. If you recommenced the manufacture of "Carnos," would you be content with your 1-30th of a grain of arsenic, and would you be content with the procedure described to us just now?—I think I should be justified in saying yes, considering the quantity of the substance that is used. A quarter of an ounce is the largest amount that you would use for a large cup. That is a very small quantity indeed, and works out lower per grain per pound than any malt that would be placed on the market.

11306. I do not doubt your calculation, but I do seriously doubt whether the public, if they knew, would accept the risk?—With 1-30th of a grain per pound?

11307. Yes?—Then the only thing, if that is the impression, would be that some other addition to the process must be tried in order to lower it still further.

Mr. Norris Walker, called; and Examined.

11308-9. (*Chairman.*) I believe you are the manager, are you not, of Messrs. Castell and Brown, who are large jam makers, confectioners, and table syrup manufacturers of London?—Yes.

11310. I suppose you may be described as large wholesale dealers?—Wholesale confectioners and dealers.

11311. I suppose your firm sells a great quantity of golden syrup in the course of a year?—Yes, we get rid of a good lot of golden syrup.

11312. Is it made by your firm, or do you buy it from the manufacturers?—We buy it direct from the manufacturers, from the refiners.

11313. Have you any written agreement or undertaking with regard to this syrup when you purchase it that it shall be arsenic-free in every case?—Yes, it is guaranteed absolutely free from arsenic, and made from cane sugar only.

11314. Do you yourselves apply any test to this syrup?—No, we take the guarantee.

11315. You are satisfied with the guarantee?—Yes.

11316. Do you always employ the same manufacturer?—Yes, for the syrup.

11317. For how many years have you employed him?—I suppose they have supplied the firm for five or six years right off now.

11318. Can you show us any document or quote any document in the shape of a guarantee?—The guarantee is stamped on every invoice.

11319. It is merely stamped "This is arsenic-free"?—There is a rubber stamp and the signature of the firm guaranteeing the purity. I have some of the guarantees. These are the styles of guarantees we get from different people. (*The guarantees were handed in.*)

11320. These are only guarantees for colours used in confectionery, not for golden syrup?—Yes, colours and essences.

11321. Some of your golden syrup is sold as containing added glucose?—Yes, it is, but there is always a guarantee given with that by the firm—that is, by ourselves.

11322. You use glucose, of course, in confectionery?—Yes, in large quantities.

11323. You are aware of what happened in regard to glucose?—Yes, but we have a guarantee.

11324. You are aware of the notorious case in 1900?—Yes.

11325. With regard to analysis, do you employ an analyst at all?—We have not, but if there were any occasion to do so most decidedly we should.

11326. If there was any occasion?—If we had any doubt.

11327. How would you define an occasion of that kind—if you were urged to do it, or if you had any suspicion?—If we had any suspicion. But dealing with one firm continually for years, and getting their guarantee on the invoices or a written guarantee when we buy the stuff, we take it from the guarantee. They are nrms of good standing, and I do not suppose they would dare to give a guarantee like that unless they were absolutely sure themselves.

11328. But still, if there were any accident, or any case of carelessness—in the best of firms there may be some cases of carelessness, may there not—do not you think you would be more secure if you analysed for yourselves?—It would certainly be a double warranty.

11329. What you urge is, that you have been connected with this business for many years, and for a long time have employed the same firm, with excellent results so far, and so long as you employ that firm you are satisfied from experience with their guarantees?—Yes.

11330. Supposing you changed the firm; in that case would you think it necessary to employ an analyst?—We

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might do so in certain colours, but having found that the colours we are using suit our purpose, we should not think of changing.

11331. The general custom, I understand, of your firm in purchasing glycerine or colouring matters for confectionery or jam, or anything of that kind, is to rely upon the guarantee only?—With regard to glycerine, which you mentioned, we use very little indeed; I do not suppose we use 56lbs. in the course of a year.

11332. Of course you are aware of the liability of glycerine to contain arsenic?—Yes.

Glycerine not tested.

11333. And you do not test for that?—No, it is used in such minute quantities that it is hardly worth while.

11334. But still, if a minute quantity turned out dangerous or mischievous, there would be serious injury to the trade, would there not?—I am afraid that the quantity used is so very very small indeed that it really would not be noticeable.

11335. Is your practice as you have described it generally speaking, the practice of the trade at large?—Yes, taken generally, it is. They get the guarantee from the firms from which they buy, and are satisfied. But if there is any doubt about anything they would have it analysed; I should myself if I had any doubt about any of these things.

No objection to official samples being taken at factory.

11336. Would you object to an officer of any Government Department visiting the works of your firm from time to time to take a sample of the materials you are using?—No, I should welcome him.

11337. You would not think it inquisitorial or injurious to the business if such were done?—Not at all.

11338. In fact, you would look upon it as a kind of extra precaution?—That is so; I should not mind how often they took an analysis.

11339. Before this unhappy occurrence in Manchester were you and your firm generally aware of the danger of the presence of arsenic in these materials?—At that particular time I was not connected with the firm.

11340. You have only more recently been connected with it?—Yes. But still I used to handle a lot of the different ingredients used in confectionery for many years previous to that.

Manufacturer will send an analysis if asked.

11341. From your own knowledge, have wholesale manufacturers taken greater precautions since these occurrences, or have they simply continued the system which they used before?—I think a precaution has been taken by these guarantees. I think nobody will buy unless they have a guarantee, and if necessary they will also produce an analysis. If we wanted the manufacturers to send an analysis of glucose, or syrup, or essences, or anything else, they would do so.

11342. In every case they would send you the analysis on which the guarantee is founded?—Yes, if we desired.

11343. That is always available to you?—Yes.

11344. (*Sir William Church.*) I suppose this system of having guarantees has only come in quite lately?—No, it has been in vogue for years; for some years, that is to say, anybody who is careful with what they are buying.

11345. Not subsequent to the alarm which arose from the arsenicated glucose of Bostock's?—No, I think not.

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11346. Before you were with Messrs. Castell and Brown, I suppose you were in the same sort of business?—Yes, I used to handle all the different essences and things before they were manufactured.

11347. And you were aware, therefore, that in the firm with which you were connected they used to require a guarantee?—I was the head of the firm myself, and I used to require guarantees.

11348. I only wanted to know whether it had been customary before the last three years to have these guarantees?—Yes, it has been customary.

Former guarantees did not specify arsenic.

11349. Those former guarantees did not in any way include arsenic?—No. They used to give a guarantee that the article supplied was pure; the word "arsenic" did not appear. I think there are several things which ought to be looked for, irrespective of arsenic, in the manufacture of certain things. I am almost afraid to say, but still I know for a fact that some of the manufacturers are not too careful about those things. For instance, cleanliness of their utensils. When they are using such things as natural acids, lemon, or anything of that sort, I myself have noticed very often that perhaps a pan which has been used for making lemon jelly overnight, in the morning has a thick sediment of verdigris on it. If that is not properly cleaned out and very carefully cleansed, and thoroughly washed, the next lot of jelly put into it would be absolutley poisonous.

11350. There is no doubt that care should be taken in the cleanliness of the utensils. Do you use much citric or tartaric acid in your trade?—We use a certain quantity.

11351. Is that bought under a guarantee?—Yes, it is bought under the guarantee of one of these firms, Stevenson and Howell.

11352. (*Dr. Whitelegge.*) Do you use American glucose?—Yes.

Foreign glucose, guaranteed by agent.

11353. In what way does that come to you? Who guarantees it?—It is guaranteed by the firm we buy it of in London.

11354. Have you any understanding with them how they arrive at the certainty of their guaranteed freedom from arsenic?—They have it analysed over here, I believe.

11355. And from them you receive an assurance in writing that it is free from arsenic?—Yes, on every invoice that they deliver.

11356. Do they distinguish it as American? Do you know it is American when you receive it?—Yes.

11357. The terms of the guarantee are the same, whether it comes to you from the manufacturer or from the importer?—We buy through the agent.

11358. Through the same agent in every case?—Yes.

11359. It is the agent's guarantee, not the manufacturer's?—Yes.

Works not visited by Excise.

11360. Are your works visited by the Excise Officers for any purpose?—No.

11361. You do not come into touch with them?—No, there is nothing excisable on our premises.

Mr. E. I. Pronk, called; and Examined.

Mr. E. I. Pronk.

11362. (*Chairman.*) You are connected with Messrs. Pronk, Davis and Co., who are large manufacturers and importers of colours of various kinds for food and for textile purposes?—Yes.

11363. As regards food, is your sale chiefly for confectionery purposes?—Yes, chiefly, and cakes, also for colouring sausages.

11364. Are you a purchaser of glycerine?—Yes.

11365. To a large amount?—Fairly so.

11366. You are aware of its liability to contain arsenic?—Yes.

Arsenic in colours,

due to sulphuric acid

11367. With regard to coal-tar colours, can you explain to the Commission how the liability of these colours to contain arsenic arises?—I should say it is owing to the arsenic being present in the materials from which the colours are manufactured. For instance, sulphuric acid being largely used in the manufacture, I dare say that the commercial article would generally contain arsenic.

Mr. E. I. Pronk.

11368. Supposing the sulphuric acid could possibly be eliminated altogther, would there still be danger?—Yes, I should say that applies to most of the chemicals used in making aniline dyes.

11369. These brilliant dye colours?—Yes.

11370. There is some danger of arsenic from other chemicals?—I should say so.

11371. But the major danger would be if sulphuric acid was used?—Yes.

or to use of arsenic in manufactur

11372. Will you tell us which coal-tar colours are specially liable to contain arsenic?—At one time all anilines were made with arsenic.

11373. Do you mean directly?—Yes, arsenic was used in the manufacture of magenta, for instance, and soluble blue was made from magenta.

11374. When did the change occur in the trade, when arsenic was no longer used directly, but became incidentally mixed with the ingredients?—About 20 years ago a new process was invented for making magenta without the direct use of arsenic.

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11375. Do you consider it easy in your trade to secure colours practically free from arsenic, or does that materially add to the cost of preparing them?—No, we find it perfectly easy now.

11376. You are perfectly confident as to that?—Yes; as a matter of fact we find that out of 100 lots of colour there may be one that contains a slight trace of arsenic.

11377. Of course, you want to secure your customers as much as possible, do you not?—Yes.

11378. Therefore I should like you to detail to the Commission, generally speaking, how you carry that out. For instance, I presume you have something like a certificate, have you not, that the colours are free from arsenic?—We know from past experience that certain colours are liable to contain a little arsenic, and therefore we do not recommend them for colouring articles of consumption; but we also know that other colours are generally free from arsenic and metallic poisons, and therefore we buy those in preference. We import, say, one bulk of 5 cwt. and have it analysed, and unless we can show that it is perfectly free from arsenic and metallic poisons we reject it.

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11379. Apart from any guarantee which you may get from chemists or any process of analysis, you avoid all colours which experience shows might be dangerous in regard to food?—Just so.

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11380. Do you mean to tell the Commission that as regards food you avoid all colours which experience has shown you are dangerous?—Yes.

11381. Do you think that supposing it were made obligatory in regard to manufacturers of confectionery, for instance, to buy only those colours which were free from arsenic, it would be a serious interference with trade, or impose much extra cost?—There would be no interference, there would be no extra cost, and it would be quite easy to do so.

11382. If that were done, you think that, so far as your trade is concerned, any danger from arsenical poisoning would be restricted to possibilities with regard to colours which were sold for textile purposes, apart from food consumption?—If I may make a suggestion, the only condition that would have to be attached to the use of aniline colours would be that only such colours are to be used that are not manufactured by the arsenical process.

11383. You think that that would give security?—That would give perfect security, except in so far as there may be some accidental traces of poisons in colours from sulphuric acid or other chemicals; but the quantity would be so small that it could not possibly be harmful.

ic in rmenia.

11384. Have you anything you can tell us with regard to bole armenia? Do you guarantee freedom from arsenic in such a case as that?—I should not guarantee it free from arsenic unless we had had it tested first. But personally I do not recommend bole armenia for colouring any articles of consumption.

11385. Is it used in your trade much for textile purposes?—No, it is not; it is used as a horse physic.

11386. Do you make use of any system of analysis in your trade?—No, we do not, except that we go to some good analysts.

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11387. You go to them?—Yes, we go to good analysts for analyses; we do not do them ourselves.

11388. Do you analyse samples of the different colours that you purchase?—Yes. We analyse all colours we purchase for confectionery or for articles of consumption.

11389. When you say consumption, you mean when they are used for confectionery or food purposes?—Yes.

11390. You do not do so in regard to any colours that are used for textile purposes?—No, we do not.

11391. You do not think it necessary in that case?—No.

11392. But in regard to colours used for textile purposes, you advocate, as I understand it, that all colours which may possibly contain arsenic can easily be avoided?—Not for textile purposes.

11393. You mean for food purposes?—Yes, only for food purposes.

11394. For food purposes you think it very easy to get security by avoiding all colours which have been proved possible to contain arsenic on analysis?—Yes, all colours that have been made under the old arsenical process.

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11394*. That is distinct from the position to-day. In regard to all colours which are used for confectionery or food, do you think the best security is through analysis?—Yes, as an extra precaution; although, as I said, all colours that are made by the non-arsenical process, if they contain any arsenic or metallic poisons, the amount would be so small as to be harmless. But still, as an extra precaution, we always have our colours analysed, so that we can give a clean bill.

11395. You have indicated the position you have taken up, and you define to us the difference between the old days, when arsenic was used in the production of these colours, and the system which you have adopted for the last 20 years, when that system has no longer prevailed; but can you tell us generally what the system prevalent amongst the trade is as regards security from the presence of arsenic in colours used in confectionery or food?—The supply of colours is in the hands of a comparatively small number of firms in England.

Small number of firms supplying colours.

11396. I am aware of that?—For the purpose of colouring articles of consumption I may say there are only perhaps a dozen firms in England who supply such colours, and they buy them from a still smaller number of manufacturers. We, for instance, supply most of the wholesale firms who deal with confectioners.

11397. You think you are the largest dealers?—I should say we are. I do not want to mention any names, but many firms who are well known, and occupy more prominent positions than mine does, buy their colours from us, and we give them a guarantee that all the colours shall be free from arsenic and metallic poisons.

11398. The whole trade really is contracted within a narrow scope?—Yes.

11399. That being so, can you state that as regards the whole trade generally any precautions which are taken are on the same lines that you have detailed to us to-day?—Yes, I am sure they are.

Precautions are general.

11400. You say that from your own knowledge?—Yes, from my own knowledge. If you look up the advertisements of firms selling colours, you will find they all state they guarantee their colours free from arsenic and metallic poisons.

11401. I do not know whether you have read a report of Mr. Hammond Smith's, but in that report there is a reference to sausage makers and others who purchase mineral and other colours, without any security of purity, from middlemen who themselves know nothing of the purities of the colours they sell. Have you anything to say with regard to that?—No doubt it is so. But personally I do not sell much in the way of colouring matters for sausages, certainly not the ordinary thing which is sold, which is oxide of iron, and which I should say is not advisable to use for sausages.

Mineral colouring matters sold without knowledge of purity.

11402. Not advisable on the score of health?—Yes. I am not a chemist and not a doctor, but I should say that to add a large quantityof oxide of iron would be detrimental to the system. It might set up blood poisoning or irritation. Again, it is very difficult to obtain oxide of iron which is free from arsenic—we find it so.

11403. Is it your experience of oxide of iron that you find it very difficult to procure it without some arsenic in it?—Yes. It is possible, and we do obtain parcels free from poison, but most of them contain arsenic.

11404. Do you use very much of it?—We use a good deal.

11405. In what process in your business?—We sell it for colouring sausages:—making paints.

11406. Do you think it ought to be looked upon with suspicion?—Yes, I think it ought to be.

Objects to oxide of iron in food.

11407. (*Sir William Church.*) I rather gathered from what you said to the Chairman that a good many of these colouring matters you do not manufacture yourselves; for instance, you are only agents for aniline colours?—Just so.

11408. And it is those that you submit to analysis before you send them out to your customers?—That is so.

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11409. What colours do you principally make yourselves?—We do not make any ourselves. We mix a good many, but we do not manufacture them, except in so far as we make up paste colours with the colours we import.

11410. I suppose the colours that are used for foods are chiefly in connection with confectionery and sweetmeats; do you sell much colouring matters to agriculturists for cheese, butter, and such things?—We do not sell anilines for colouring butters, except one colour soluble in oil; there is a good deal of that used.

11411. For cheeses?—Yes. We also sell a good deal for colouring cakes; in fact, all cakes are coloured now with aniline colours.

11412. I suppose, practically speaking, these aniline colours have almost destroyed the use of vegetable colours for confectionery?—Yes, practically so; and, of course, I consider that aniline colours, if free from poison, are much better to use than vegetable colours.

Aniline colours preferred to vegetable.

11413. (*Chairman.*) Better for the consumer?—Yes.

11414. (*Sir William Church.*) Quite apart from their containing arsenic or any other poisonous mineral, aniline colours themselves, or some of them, are very prejudicial, are they not?—No, I think not; why should they be?

11415. I am not a sufficient chemist to say, but we have had it in evidence before the Commission that some of the aniline colours, quite apart from containing arsenic, are deleterious to animal life?—I do not think that has ever been proved. In fact, when complaints have been made, for instance about coloured garments setting up blood poisoning, it has always been proved that it was something else in the material that caused the mischief, some of the chemicals, most likely some of the mordant, but never the colouring.

11416. Of course, they are used in such infinitesimal quantities that probably it is rather a theoretical objection than a practical one, but the Commissioners on the use of Preservatives and Colouring Matters have distinctly given it as their opinion that some of these aniline dyes, apart from containing arsenic, are injurious?—I am not aware of it.

11417. What would be your objection to the vegetable colours?—Vegetable colours are exceedingly weak, and a large quantity must be used to produce a large effect. For instance, cochineal was used in confectionery, and to get a good colour one had to use a large percentage of it. Cochineal is an animal matter, but it is very seldom used as cochineal.

11418. Is there any known deleterious effect from cochineal?—Yes, it produces sickness if too much is taken inwardly.

11419. It is a very inert substance, is it not? It used to be used in medicines?—Yes, in very small quantities. But when it is used to get a deep colour in jams or in confectionery, you have to use such a lot that it is a different matter altogether. Then again, it is not used as cochineal. It is made into carmine, and then used as a cochineal. Carmine is made by certain chemical processes in which they use different chemicals, and possibly those chemicals may contain poisons. I have had samples of carmine analysed, and found traces of lead in them.

11420. Carmine was made-, I think, by the action of acid upon cochineal, was not it?—No, there are different processes, but I think it is made with ammonia and starch.

11421. I suppose, as a rule, most vegetable colours have a very slight physiological action?—I do not know. Turmeric is used largely in pickles, for instance, and also for colouring confectionery. Turmeric is powdered very finely, more or less; sometimes not finely enough, in my opinion, and I should say that turmeric, if not fine, must be very deleterious to the system.

11422. As an irritant?—Yes, and of course it is used in medicines for that purpose.

11423. Is saffron still used for colouring confectionery?—No, it is too dear; it is not used now to any extent.

Usually knows if colours ordered for food purposes.

11424. (*Dr. Whitelegge.*) You distinguish, I understand, between the products which are going to be used for food and those which are not?—Yes.

11425. Do you always know which purpose they are destined for?—Yes.

11426. How do you know? By seeing the name of the firm to whom you are selling the goods?—Yes, and from the distinctive names of the colours.

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11427. But how do you always know whether it is going to be used for textile purposes or for food—supposing you received an order from a new customer?—I see your meaning now. Of course, where we supply dealers we very often ask the question: "For what purpose are the colours intended?" When we get orders from confectioners or similar trades we know what they are to be used for.

11428. But if you received an order from Manchester or from Leeds from a new customer, you would not at first know whether it was for food or for textile purposes?—We should, because it is unlikely that we should get an order straight away without a previous inquiry as to shade, quality, and price.

11429. Which would give you the clue?—Just so.

11430. You think you do know, as a matter of fact, which they are meant for?—I might say that we always do.

11431. And in the case of articles for food, you are careful to secure absence of arsenic?—Yes.

11432. In other colouring matters you do not think that necessary?—I do not, because I think the arsenic or metallic poisons would not be taken up by the textile fabrics; it would be run away in the water.

11433. When you sell to dealers as distinct from consumers, I understand that you make inquiries?—We always do.

11434. You said that certain colours were specially liable to contain arsenic, and that you did not recommend them for use in confectionery?—Yes.

Colours not recommended for confectionery.

11435. Can you tell us the names of some of those colours?—Arsenical magenta, blues, and various colours made from arsenical magenta base.

11436. You are referring more particularly to the use of arsenic in the manufacture of these things; there may be arsenic, even if arsenic is not intentionally used in the manufacturing, in some of the colours?—Yes, there may be accidental traces, but they would be very small.

11437. For example, do you know a colour called apple-green?—Yes.

11438. Is that liable to contain arsenic?—No.

11439. Not at all?—No.

Arsenic in apple green.

11440. We have it on record that a sample lately examined did contain arsenic. You do not regard that colour as a dangerous colour; you would not consider it an improper colour to be used in confectionery?—Not at all; apple-green is always made up from a yellow and a blue; our analyses have never shown apple-green to be more likely than other colours to contain arsenic.*

11441. What is your practice with regard to mineral colours? You spoke of bole armenia, which I understand you buy and sell?—Yes.

11442. Do you require any guarantee from the person from whom you receive it of, freedom from arsenic?—No.

11443. Do you make any analysis?—Yes.

Arsenic in bole Armenia.

11444. Do you find arsenic in bole Armenia?—Very often.

11445. What happens when you do find it?—We reject it, and sell it for making paint.

11446. Then, if you are selling bole armenia with any idea that it is going to be used for food, do you give a guarantee of freedom from arsenic?—Yes.

11447. Does that apply to other mineral colours?—Yes, as far as they are used for the purpose of colouring articles of consumption, but I hardly think there is anything besides oxide of iron in the way of mineral colours which we should care to sell.

* Witness's attention having been drawn to the result of an analysis of a sample of apple green taken at a confectioner's, which was found to contain 1-12th grain arsenic to the pound, he has since written to the Commission that this quantity of arsenic would certainly be detected by the analyst employed by his firm and that (for food purposes) he would reject any bulk of colour containing more than 1 part of arsenic in 100,000 which is approximately limit of the test which his analysts employ.

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11448. (*Chairman.*) Supposing you reject any colour as containing too much arsenic for food purposes, would you use it for textile purposes?—Yes.

11449. With regard to wall-papers, we have heard a complaint of the danger of colours in wall-papers. Have you anything like a limit of arsenic when selling colours which you know are to be used for wall-papers?—We take no guarantee, and we sell what we are asked for for wall-paper.

11450. Without any reference to the quantity of arsenic they may contain?—Yes.

11451. Since you have been in the trade, have you heard of any injury arising from wall-paper; have you ever come across that fact in the course of your trade?—No, I do not think I have.

11452. You have not made, in the course of your trade, any special reservation, or at least any difficulty in regard to the question of selling colours which are to be used for wall-paper?—No.

Distribution of colours to butchers, &c.

11453. I will just quote you a sentence from Mr. Hammond Smith's report. "Similarly with regard to the use of armenia bole and colouring matters of all kinds in meat preparations, I have been informed alike by a colour maker, a colour seller, and a colour user, that it is never the practice of the meat trade to require any guarantee of purity of the colours used, or to have the colours analysed. These colours are frequently procured at shops where sundry butchers' requisites are sold. At these shops the colour is obtained from middlemen without guarantee of purity." Can you give us any information with regard to that?—I should say that the middlemen who supplied them to the butchers would obtain their colours from third parties, who would be careful as to what they sell. I know we sell to several distributors in the meat market to whom we have given a guarantee.

11454. Middlemen?—Distributors, who sell to the middlemen.

11455. And you would give them a guarantee?—Yes.

Mr. A. E. Palmer, called; and Examined.

Mr. A. E. Palmer.

11456. (*Chairman.*) I believe you are a large confectioner and cake manufacturer, carrying on business in Bristol?—Yes.

11457. You use various chemical substances, glycerine, glucose, and baking powders, in the process of making cakes?—Yes.

11458. I suppose you are aware, or at all events you have found out in the course of this inquiry from other sources, that these ingredients are liable to contain arsenic?—Yes, I understand that some of them are.

11459. Can you tell the Commissioners what safeguards, if any, you have adopted from time to time to secure that these substances are arsenic-free?—We have had them guaranteed as being pure from the manufacturers or merchants from whom we have bought them. I have the guarantees in my pocket from the various people. Taking glycerine first, this is the form of guarantee from Messrs. Lever Bros. (*Handed in.*)

11460. The guarantees are dated 1902. Has it been part of your practice to get these guarantees since you have been in business, or have you only taken it up lately?—The guarantee I have handed in refers to the last ton of glycerine we bought. We use only a little of it.

11461. You use little glycerine?—Very little in cakes.

11462. Have you always been aware since you have been in business that glycerine was liable to contain arsenic?—I cannot say I was until that scare.

11463. When did you first gain the information?—I think it was about the time of the arsenic scare. I had a conversation then with my doctor, and I asked him if he could tell me any things that he thought would be liable to contain arsenic that we were using in our goods, and he told me then he thought that glycerine might.

11464. From the very fact of your questioning him then, it appears that up to that time you were not aware of it?—I cannot say that I was. Of course, there is very little glycerine used in best-class goods; it is chiefly used in the cheaper grades of cake.

11465. Do you take any other precautions besides these guarantees such as you have handed in?—We send occasionally to the public analyst at Bristol.

11466. But you do not send a sample of all invoices?—Not of all the parcels that come in.

11467. You do it now and then?—Yes.

11468. But do not you classify the ingredients you use? Are you not aware that some are more liable to contain arsenic than others, for instance?—Taking that, for instance, I should think it would not. We do not buy in a competitive way goods such as that. With regard to all our chemicals and glucose and glycerine, we buy the best quality, and not the low-class forms, so that we expect to get a good and pure article.

11469. Do you use cream of tartar substitute?—No.

11470. Did not you at one time use it?—Not since Mr. Hammond Smith visited me.

11471. You did use a little previously?—Yes.

11472. I believe Mr. Hammond Smith took a sample when he went to your works, and found that it contained some arsenic, did he not?—I gave him a sample of the cream powder when he visited our works, and he told me that he thought it was advisable not to use it, and I discontinued using it.

Quantity of glycerine in cakes.

11473. But you use a considerable percentage, relatively speaking, of glycerine, of glycerine in the materials of which you make your cake—you use 1½ per cent. of glycerine in the materials, do you not?—No, I should say about ½lb. to 1cwt., that is what we are using in "medium rich" cakes. For cheaper cakes a slightly larger amount would be taken—1¼lbs. of glycerine to 100lbs. of mixing. I cannot say what others are using.

11474. Are you satisfied with the precautions which you now take with reference to glycerine?—The guarantee is the only satisfaction we have; they say the glycerine is chemically pure.

11475. Occasionally, you say, you submit these samples to analysis?—Yes.

11476. That is your system as regards the guarantee?—Yes.

Should be standards available for manufacturer.

11477. Have you any other suggestion to make as to any further guarantee, or are you quite satisfied so far as the conduct of your business is concerned, that there is no danger to the consumer?—I should consider that if there is a percentage of arsenic which is allowed under the present test, it would be advisable to raise the test. If it is not pure enough, I should think the test ought to be raised.

11478. The standard should be raised?—Yes—that is in the interest of those firms who are not in a position to employ chemists of their own. If one employed chemists they would be analysing for impurities all the time.

11479. They would analyse a sample of everything bought in bulk?—Yes.

11480. (*Sir William Church.*) Do you use colouring matter at all in the manufacture of your goods?—Yes, a little.

11481. In ordering colouring matter, do you use any precautions as to the colours?—They are guaranteed as being absolutely pure under the Sale of Food and Drugs Act.

11482. Do you rely upon the guarantee of the firm which supplies them?—Yes.

11483. Do you chiefly use aniline colours or vegetable colours?—Vegetable colours, but it is very little that we use of them—only a little yellow, except in the case of icing sugar, when there is a little pink colour used in addition.

11484. Do you use turmeric?—No, the egg-yellow takes the place of that really.

11485. Nor cochineal?—No.

11486. In your opinion, the aniline colours, when guaranteed pure, are quite harmless?—The vegetable colours.

11487. You think they are the best?—Yes.

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11488. Do you use vegetable colours, saffron?—No, we do not use that. It is egg-yellow, commercially termed. But I understand they are vegetable colours, not anilines.

11489. Is it usual in your trade to use chiefly vegetable colours?—I believe so. They are always advertised and sold at such.

11490. Of course you are not a sweetmeat maker?—No.

11491. Can you tell me anything about the use of baking powders—I suppose you use them a good deal?—We use cream of tartar, carbonate of soda, and a small proportion of tartaric acid in some goods, and carbonate of ammonia.

11492. Do you use phosphate of soda at all—is that mixed with the baking powders?—If you are referring to the substitute for cream of tartar, I have not used that since Mr. Hammond Smith was in Bristol, or soon after then.

11493. But it is used, or was once used?—I believe it is used now. It is advertised in all the trade journals: there are numerous substitutes.

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11494. And I suppose in the same way with the baking powders, you rely upon the guarantee of the vendor?—If you are referring to baking powders, we mix our own powders.

11495. Do you take any steps for seeing that the ingredients are pure?—Yes.

11496. The materials that you use for making the baking powder you buy under guarantee in the same way that you do the colouring matters?—Yes.

(*Secretary.*) I have received a series of letters from Mr. Beach, Secretary of the Maltine Company. I understand the Commission do not wish Mr. Beach to be called at this stage, but that his letters should be printed as an appendix?—(*Chairman.*) Yes.

TWENTY-EIGHTH DAY.

Friday, March 27th, 1903.

At 1, Chapel Place.

PRESENT:

The Right Hon. Lord Kelvin in the Chair.

The Right Hon. Sir William Hart Dyke.	Professor Thorpe.
Sir William Church.	Dr. Whitelegge.

Dr. Buchanan, *Secretary.*

Mr. J. Lithiby, called; and Examined.

Mr. J. Lithiby. 27 Mar. 1903.

11497. (*Chairman.*) What is your position at the Local Government Board?—I am assistant secretary, in charge of the Public Health and Local Acts Department.

11498. Are the reports of the public analysts dealt with in your Department?—They are.

Duties of Local Government Board under Sale of Food and Drugs Acts.

11499. What are the duties of the Local Government Board under the Sale of Food and Drugs Acts?—The only express duty of the Local Government Board, prior to the Act of 1899, was under Sections 10 and 19 of the Sale of Food and Drugs Act, 1875. Under Section 10 the appointments of Public Analysts made by the authorities specified in the section are subject to the Board's approval. The Board are empowered to require satisfactory proof of competency to be sent to them, and they may give their approval absolutely, or with modifications, as to the period of the appointment and removal, or otherwise. If local authorities fail to appoint public analysts as required by Section 10, the Local Government Board are empowered to require them to make the necessary appointment. Under Section 19 of the same Act, every analyst is required to report quarterly to the authority appointing him the number of articles analysed by him under the Act, during the foregoing quarter, and to specify the result of such analyses and the sum paid to him in respect thereof. Such report is to be presented at the next meeting of the authority appointing the analyst, and every such authority is required annually to transmit to the Local Government Board, at such time and in such form as the Board shall direct a certified copy of such quarterly report. I hand in a copy of the circular letter issued by the Local Government Board, specifying the form in which the quarterly reports are to be sent to them, together with a specimen form of analysts' quarterly report which the Board have suggested for use by public analysts.

Extremely limited before Act of 1899.

It will be seen that the Board's functions under this Act, are extremely limited. As a matter of fact the reports which the Board receive are tabulated in the Department, communications are addressed to local authorities who appear not to have adequately carried out the provisions of the Acts, suggestions are made to them from time to time as to what they should do, and remonstrances are addressed to them when they fail to do it. The Board have no compulsory powers in the matter. I may state that the subject of the administration of the Sale of Food and Drugs Acts, so far as the Local Government Board is concerned, was fully explained in the evidence of Mr. Preston Thomas before the select committee of the House of Commons on Food Products Adulteration in 1894—see page 1 of the evidence appended to the report (253 of 1894).

In 1899 an amending Act was passed by which the powers of the Local Government Board were enlarged, and powers were also given to the Board of Agriculture. Section 2 of the Act of 1899 provides as follows:—

Mr. J. Lithiby. 27 Mar. 1903.

Additional powers of Local Government Board under Act of 1899.

(1) The Local Government Board may, in relation to any matter appearing to that Board to affect the general interest of the consumer, and the Board of Agriculture may, in relation to any matter appearing to that Board to affect the general interests of agriculture in the United Kingdom, direct an officer of the Board to procure for analysis samples of any article of food, and thereupon the officer shall have all the powers of procuring samples conferred by the Sale of Food and Drugs Acts, and those Acts shall apply as if the officer were an officer authorised to procure samples under the Sale of Food and Drugs Act, 1875, except that—

(*a*) The officer procuring the sample shall divide the same into four parts, and shall deal with three of such parts in the manner directed by Section 14 of the Sale of Food and Drugs Act, 1875, as amended by this Act, and shall send the fourth part to the Board, and—

(*b*) The fee for analysis shall be payable to the analyst by the local authority of the place where the sample is procured.

(2) The Board shall communicate the results of the analysis of any such sample to the local authority, and

thereupon there shall be the like duty and power on the part of the local authority to cause proceedings to be taken as if the local authority had caused the analysis to be made.

It will be seen that by this Section the Board are only empowered to act in relation to any matter appearing to them to affect the general interest of the consumer. They can only take samples and obtain analyses of them by the analyst employed by the local authority of the place where the sample is procured, just as the local authority itself could do. Beyond that, however, the Board's duty is limited to communicating the result of the analyses to the local authority, and it then becomes the duty of the local authority to cause proceedings to be taken as if they themselves had caused the analysis to be made.

Under Section 3 of the Act of 1899, if the Local Government Board, after communicating with the local authority, are of opinion that the local authority have failed to execute or enforce any of the provisions of the Sale of Food and Drugs Acts in relation to any article of food, and that their failure affects the general interest of the consumer, the Board may, by order, empower one of their officers to execute and enforce those provisions, or to procure the execution and enforcement thereof in relation to any article of food mentioned in the Order. Under this Section it will be seen that the Board can only act when they are satisfied that there has been default on the part of the local authority, and even then their action is limited to putting the Act in force with regard to the specific articles of food which may appear to the Board to require dealing with.

11500. Have the Local Government Board taken any action under the Act of 1899?—If by that question is meant "whether the Board have themselves directed one of their officers to procure samples," the answer is "No." The Act was passed on the 9th August, 1899; by Section 28 (2) it came into operation on the 1st January, 1900. The Board could have no information as to the working of the Act by local authorities until the reports of 1900 were received by them in January, 1901, and subsequent months. When these reports came to be tabulated it appeared that the total number of samples analysed in 1900 was 62,858, *i.e.*, one to every 461 of the population in 1891, or nearly 19,000 in excess of the number of samples analysed in 1899.

In commenting in their annual Reports on the returns which the Board have received from public analysts, they have on more than one occasion expressed the opinion that at least one sample should be taken for every thousand of the population. This standard has in recent years been more than observed so far as the country generally is concerned, and having regard to the number of samples taken in 1900, it is clear that there was no ground for the intervention of the Local Government Board so far as the country generally was concerned. In their Annual Report for 1900–1 the Board remarked:—"In London one sample was analysed for every 312 persons, and in the provinces one for every 502. The increase is no doubt largely due to the fact that under the provisions of the new Act already referred to local authorities within the meaning of the Sale of Food and Drugs Acts now have a duty specifically passed upon them to carry out and enforce the provisions of the Act. During 1900 many local authorities have for the first time obtained samples for analysis, and many others have largely increased the number taken. We have communicated with the authorities of districts in which the work done under the Acts appears to us to be still insufficient, reminding them of their duty under the Act of 1899, and urging them to exercise the powers entrusted to them by the legislature for the repression of adulteration."

11501. You say that the increase was due to the fact that under the Act of 1899 local authorities now have a duty specifically cast upon them to carry out the provisions of the Sale of Food and Drugs Acts. Had they no such duty prior to 1899?—No. Prior to 1899, local authorities were merely empowered to carry out the provisions of the Acts. By Section 15 of the Act of 1875 it is provided as follows:—"Any medical officer of health, inspector of nuisances, or inspector of weights and measures, or any inspector of a market or any police constable under the direction and at the cost of the local authority appointing such officer, inspector, or constable, or charged with the execution of this Act, may procure any sample of food or drugs, and if he suspect the same to have been sold to him contrary to any provision of the Act, shall submit the same to analysis," etc. It was within the power of the local authority to direct certain specified officers to take samples, but nowhere were they directly required to do so. By Section 3 of the Act of 1899, however, it is provided that it shall be the duty of every local authority entrusted with the execution of the laws relating to the Sale of Food and Drugs to appoint a public analyst, and put in force from time to time as occasion may arise, the powers with which they are invested, so as to provide proper security for the sale of food and drugs in a pure and genuine condition, and in particular to direct their officers to take samples for analysis.

Local authorities now have specific duty of carrying out provisions of Sale of Food and Drugs Acts.

11502. The statistics for the year 1901 would be received in January, 1902, would they not?—Yes

11503. How do they compare with previous years?—The facts are set out in page cli. of the Board's Report for 1901–2. The total number of samples analysed in 1901 was 67,841, or nearly 5,000 in excess of the number taken in 1900. Commenting on these figures the Board state as follows:—

"This gives an average of one to every 479 of the population of 1901 for the whole country. In London one sample was analysed for every 291 persons, and in the provinces one for every 536 of the population. This increase, following on the very large increase noted in our last Report, is highly satisfactory. The following table shows that with the increase in the number of samples analysed in successive quinquennial periods there has been a considerable decrease in the rate of adulteration." I need not quote the table perhaps. The Report goes on to say:—"There are still a few districts in which the work done under the Acts is small in amount in comparison with the population, and in these cases we have communicated with the local authority, calling attention to their duty under Section 3 of the Sale of Food and Drugs Act, 1899, and urging them to take steps to carry out the Acts with efficiency in the future." That is all the action which the Board have thought it necessary to take up to the present time.

11504. Have you received the reports for the year 1902?—Most of the reports have now come in, and they are being tabulated at the present time. I am unable to say as yet what number of samples were analysed during the year 1902, or to what extent local authorities who were not carrying out the provisions of the Acts in 1900–1 have improved in this respect in the year 1902.

11505. What is the total number of authorities who appoint public analysts under the Sale of Food and Drugs Act?—According to the Board's report for 1901–2 the number of districts for which the Board had approved the appointment of public analysts was 231. The total number of public analysts in England and Wales at the end of that year was 126.

Number of local authorities appointing public analysts.

11506. What details are public analysts required to give in their reports to local authorities?—That is specified generally in Section 19 of the Act of 1875, which I have already quoted. They are to specify the result of each analysis, and the sum paid in respect thereof. The form which I have put in, which was issued by the Local Government Board for the guidance of public analysts, amplifies this a little In the form the particulars asked for are:—

Terms of public analyst's report.

(1) The nature of the article submitted for analysis;

(2) Whether the sample was submitted to the analyst by an officer acting under the direction of a local authority under Section 13 of the Act, and if so, the name of such authority;

(3) The result of analysis, showing whether the sample was genuine or adulterated, and if adulterated what was the nature and extent of the adulteration;

(4) The sum paid in respect of the analysis; and

(5) Observations.

I may add that it is the practice of the Board to enquire in what cases proceedings have been taken for offences against the Acts, and to ascertain where possible the amounts of the fines and costs which are inflicted by the magistrates. As a result of their examination of the figures supplied in regard to proceedings the Board have communicated with the Home Office, and the Home Office have issued a circular to Justices, drawing their attention to the small fines imposed in many cases and suggesting whether it would not be desirable to increase the amount of fines in cases of a particularly bad kind.

Local Government Board inquiries as to proceedings and penalties.

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Samples under Acts must almost always be taken from retailer.

11507. It is the fact, is it not, that under the Sale of Food and Drugs Acts a sample can only be purchased from some dealer in the finished product?—Practically that is so. Under the Act of 1879, Section 3, samples of milk might, however, be taken at railway stations, and by Section 14 of the Act of 1899, "The provisions of section three and section four of the Sale of Food and Drugs Act Amendment Act, 1879 (relating to the taking of samples of milk in course of delivery), shall apply to every other article of food. Provided that no samples shall be taken under this section except upon the request or with the consent of the purchaser or consignee."

No public authority has general power of inspection or sampling at place where food is prepared.

11508. Has any administrative authority power to enter places where food is prepared, that is to say, food factories, with a view to ascertain whether there is any liability of the introduction of deleterious substances such as arsenic, in the case of particular food products?—Speaking generally, I do not think that any administrative authority has any such power. I do not know to what extent the officers of the Inland Revenue are empowered to enter malt houses with a view of examining malt in the process of manufacture; or stores or warehouses where sugars and sugar substitutes are kept. Certainly the local authorities under the Sale of Food and Drugs Acts have no such powers.

11509. Have the local authorities power to take samples of food ingredients, or of finished foods, at the factory?—I think not. If the factory is a place where the food products produced in it are sold by retail, the inspector of the local authority would be entitled to procure samples of the food for analysis. By Section 17 of the Act of 1875. "If any such officer, inspector or constable as before described shall apply to purchase any article of food or any drug exposed for sale or on sale by retail on any premises or in any shop or stores, and shall tender the price for the quantity which he shall require for the purpose of analysis, not being more than shall be reasonably requisite, and the person exposing the same for sale shall refuse to sell the same to such officer, inspector or constable, such person shall be liable to a penalty not exceeding ten pounds."

A question arose in 1894 as to how far an inspector is entitled when purchasing a sample for analysis to demand to be supplied out of a particular receptacle in the shop. Mr. Justice Bruce, in Payne *v.* Hack, 1894, 58 J.P. 165, said: "Without going so far as to say that an inspector is entitled to go into a shop and demand to have a sample out of any vessel he likes, I think that as he had already been supplied out of a particular bottle he was entitled to have a sample taken from that bottle."

The above section has been held by the Queen's Bench Division in Ireland to apply to wholesale dealers (McHugh *v.* McGrath 1894 2 Ir. R. 71).

By Section 5 of the Act of 1879, any street or open space of public resort comes within the meaning of Section 17 of the Act of 1875 and by Section 18 of the Act of 1899, notwithstanding anything in Section 17 of the Act of 1875, where any article of food is exposed for sale in any unopened tin or packet duly labelled, no person shall be required to sell it, except in the unopened tin or packet in which it is contained.

By Section 16 of the Act of 1899 "any person who wilfully obstructs or impedes any inspector in his duty, under the Sale of Food and Drugs Acts, or by any gratuity, bribe, promise, or other inducement, prevents or attempts to prevent the due execution by such inspector or officer of his duty under those Acts, is liable on summary conviction for the first offence to a fine not exceeding twenty pounds, for the second offence to a fine not exceeding fifty pounds, and for any subsequent offence to a fine not exceeding one hundred pounds."

These are the statutory provisions on the subject; practically they come to this—that the officers of the local authority are only entitled to take samples when they are exposed for sale, or when they are in a shop where people ordinarily go to purchase articles of the kind. The officer is not entitled to enter a factory which is merely used as a factory for the manufacture of food products. I have already drawn attention to the provisions with regard to taking samples in the course of delivery.

Acts under which some power of inspection of food manufacture exists:—

11510. What statutes other than the Sale of Food and Drugs Acts are there which empower local authorities to deal with articles of food which are not satisfactory?—There are other Acts which have some bearing on this question. There is the Bread Act of 1822, which relates to the sale of bread in London and its immediate neighbourhood; and the Bread Act of 1836, which relates to the sale of bread outside the City of London and the liberties thereof, and beyond 10 miles of the Royal Exchange. These Acts contain very stringent provisions with regard to the adulteration of corn, meal, or flour, and the using of mixtures in the manufacture of bread. Section 11 of the Bread Act of 1836 provides as follows:

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Bread Act, 1836.

"It shall be lawful for any magistrate or magistrates, justice, or justices of the peace, within the limits of their respective jurisdictions, and also for any peace officer or officers authorised by warrant under the hand and seal or hands and seals of any such magistrate or magistrates, justice or justices (and which warrant any such magistrate or magistrates, justice or justices, is and are hereby empowered to grant), at seasonable times in the day time, to enter into any house, mill, shop, stall, bakehouse, bolting house, pastry warehouse, outhouse, or ground of or belonging to any miller, mealman, or baker, or other person who shall grind grain, or dress or bolt meal or flour, or make bread for reward or sale, beyond the limits aforesaid, and to search or examine whether any mixture or ingredient (not the genuine produce of the grain such meal or flour shall import or ought to be) shall have been mixed up with or put into any meal or flour in the possession of such miller, mealman, or baker, either in the grinding of any grain at the mill, or in the dressing, bolting, or manufacturing thereof, whereby the purity of any meal or flour is or shall be in anywise adulterated, or whether any mixture or ingredient other than is allowed by this Act shall have been mixed up with or put into any dough or bread of the possession of any such baker or other person, whereby any such dough or bread is or shall be in anywise adulterated, and also to search for any mixture or ingredient which may be intended to be used in or for any such adulteration or mixture; and if on any such search it shall appear that any such meal, flour, dough, or bread so found shall have been so adulterated by the person in whose possession it shall then be or any mixture or ingredient shall be found which shall seem to have been deposited there in order to be used in the adulteration of meal, flour, or bread, then and in every such case it shall be lawful for every such magistrate or magistrates, justice or justices of the peace, or officer or officers authorised as aforesaid respectively, within the limits of their respective jurisdictions, to seize and take any meal, flour, dough, or bread which shall be found in any such search, and deemed to have been adulterated, and all ingredients and mixtures which shall be found and deemed to have been used, or intended to be used, in or for any such adulteration as aforesaid; and such part thereof as shall be seized by any peace officer or officers authorised as aforesaid shall, with all convenient speed after seizure, be carried to the nearest resident magistrate or magistrates, justice or justices of the peace, within the limits of whose jurisdiction the same shall have been so seized; and if any magistrate or magistrates, justice or justices, who shall make any such seizure in pursuance of this Act, or to whom anything so seized under the authority of this Act shall be brought, shall adjudge that any such meal, flour, dough, or bread so seized shall have been adulterated by any mixture or ingredient put therein other than is allowed by this Act, or shall adjudge that any ingredient or mixture so found as aforesaid shall have been deposited or kept where so found for the purpose of adulterating meal, flour, or bread, then and in any such case every such magistrate or magistrates, justice or justices of the peace, is and are hereby required, within the limits of their respective jurisdictions, to dispose of the same as he or they, in his or their discretion, shall from time to time think proper."

Section 12 of the same Act imposes a heavy penalty if ingredients for the adulteration of meal or bread are found in any premises. It will be seen that this section gives special powers of searching the premises of millers bakers, etc. I do not think that either the Act of 1822 or that of 1836 is much used. In the evidence taken in 1874 by the Select Committee on the Adulteration of Food Act, 1872, the Chairman of the Master Bakers' Protection Society was examined, and he stated (Q. 3864) that the Act was not then carried into force. I believe that is practically so now.

Revenue Acts.

In the Customs and Inland Revenue Act, 1885, Section 8, there is a prohibition against the adulteration of beer by brewers for sale and dealers and retailers of beer. A local authority, however, would have no power to enforce the provisions of that section.

Margarine Act.

Under the Margarine Act every manufacturer of margarine within the United Kingdom of Great Britain and Ireland is required to be registered by the local authority from time to time.

Section 10 of the Act provides as follows:—"Any officer authorised to take samples under the Sale of Food and Drugs Act, 1875, may, without going through the form of purchase provided by that Act but otherwise acting in all respects in accordance with the provisions of the existing Act as to dealing with samples, take for the purposes of analysis samples of any butter or any substitutes purporting to be butter which are exposed for sale, and are not marked margarine as provided by this Act, and any such substances not so marked shall be deemed to be exposed for sale as butter."

Horseflesh, &c., Act.

Under the sale of Horseflesh, etc., Regulation Act, 1889, Section 1, no person shall sell, offer, expose, or keep for sale any horseflesh for human food other than in a shop, stall or place over which there shall be at all times painted, posted, or placed in legible characters of specified length, during which such horseflesh is being offered or exposed for sale, a notice indicating that horseflesh is sold there. And under Section 3 "any medical officer of health, or inspector of nuisances, or other officer

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of the local authority acting on the instruction of such authority, or appointed by such authority for the purposes of this Act, may at all reasonable times inspect or examine any meat which he has reason to believe to be horseflesh exposed for sale or deposited for the purposes of sale or of preparation for sale, and intended for human food in any place other than such shop, stall, or place as aforesaid, and if such meat appears to him to be horseflesh he may seize and carry away or cause to be seized and carried away the same in order to have the same dealt with by a Justice as provided in the Act.

By Section 116 of the Public Health Act, 1875, any medical officer of health or inspector of nuisances may at all reasonable times inspect and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk exposed for sale or deposited in any place for the purpose of sale or of preparation for sale, and intended for the food of man, the proof that the same was not exposed or deposited for any such purpose or was not intended for the food of man resting with the party charged, and if any such animal etc., etc., appears . . . . . to be diseased or unsound or unwholesome or unfit for the food of man, he may seize and carry away the same himself, or by an assistant, in order to have the same dealt with by a Justice. Section 117 gives power to the Justice to order the destruction of unsound meat, etc. Section 118 imposes a penalty for hindering the officer from inspecting meat, etc. Section 119 provides that on complaint made on oath by a medical officer of health or by an inspector of nuisances or other officer of a local authority any Justice may grant a warrant to any such officer to enter any building or part of a building in which such officer has reason for believing that there is kept or concealed any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk, which is intended for sale for the food of man, and is diseased, unsound, or unwholesome, or unfit for the food of man, and to search for, seize, and carry away any such animal or other article in order to have the same dealt with by a Justice under the provisions of this Act. The section also provides a penalty upon any person who obstructs any such officer in the performance of his duty under the warrant. It will be observed that under this section there is no penalty imposed for the mere concealment of the article. In order to render the party liable to penalty there must have been an exposure for sale or some such act as is made an offence by one of the previous sections.

Section 28 of the Public Health Acts Amendment Act, 1890, enacts as follows :—

(1) "Sections 116 to 119 of the Public Health Act, 1875 (relating to unsound meat) shall extend and apply to all articles intended for the food of man, sold or exposed for sale or deposited in any place for the purposes of sale or of preparation for sale within the district of any local authority."

(2) "A Justice may condemn any such article, and order it to be destroyed or disposed of as mentioned in Section 117 of the Public Health Act, 1875, if satisfied on complaint being made to him that such meat is diseased, unsound, unwholesome, or unfit for the food of man, although the same has not been seized as mentioned in Section 116 of the said Act." Corresponding provisions relating to London are contained in the London Public Health Act, 1891.

Under an old Act of 1776 relating to the adulteration of tea, an officer of Excise may obtain from justices special warrants for entering tea warehouses on proof on oath that he suspects that false leaves are there used for adulterating tea.

Provisions relating to the sale of food are contained in some local Acts. Thus, in the York Corporation Act, 1902, Section 64 enacts as follows :—

"Sections 116-118 of the Public Health Act 1875, as amended by Sec. 28 of the Public Health Acts Amendment Act, 1890, shall extend to authorise the inspection, examination, and search of any part or other vehicle or of any basket, sack, bag or parcel, whether open or closed, and the provisions of such sections shall apply accordingly."

Section 59 of the same Act provides as follows :—

(1) "Any person being a manufacturer of or merchant or dealer in ice cream or other similar commodity within the city who

(a) causes or permits ice cream or any similar commodity to be manufactured, sold, or stored, in any cellar or room in which there is an inlet or opening to a drain ; or

(b) in the manufacture, sale, or storage of any such commodity does any act or anything likely to expose such commodity to infection or contamination or omits to take any proper precaution for the due protection of such commodity from infection or contamination ; or

(c) omits on the outbreak of any infectious disease amongst persons employed in his business to give notice thereof to the medical officer ;

shall be liable for every such offence to a penalty not exceeding forty shillings.

(2) In the event of any inmate of any building (any part of which is used for manufacture of ice cream or similar commodity) suffering from any infectious disease, the medical officer may seize and destroy all ice cream or similar commodity or materials for the manufacture of the same in such building, and the Corporation shall compensate the owner of the ice cream, commodity, or materials so destroyed."

This section relating to ice cream is contained in many local Acts in one form or another. Special powers of the kind are possessed by Liverpool, Manchester, Salford, Stockport, Halifax, Leamington, York, among other places.

Limited use of Sale of Food and Drugs Acts to prevent deleterious substances in food.

11511. To what extent is it at present the practice of administrative authorities to seek and obtain information as to food products (including those of foreign origin), which through the process of manufacture are liable to contain deleterious substances such as arsenic, and which in consequence call for measures of precaution in the interests of public health ?—I am afraid that I cannot give any exhaustive answer to this question. So far as the information in the possession of the Board goes, it would appear that local authorities confine themselves to procuring samples of such foods and drugs as are on sale in their districts, and do not trouble themselves with considerations as to how such articles are manufactured. I have already dealt with the question of the manufacture of ice cream ; many towns have taken power to deal with this manufacture. Several Town Councils, *e.g.*, Liverpool, Manchester, and Cardiff, have taken special steps to ascertain the quality of milk sold in their district by arranging for systematic bacteriological examination of the supply with a view of discovering tuberculous cows that may be supplying milk to their respective districts. In Liverpool also, bacteriological examinations have been made of various other articles of food, such as tinned meat, shell fish, etc.

Powers of local authority as to condemnation of deleterious food products at factory.

11512. Has any authority power to condemn food products when at the factory and before consignment to the retailer, if it can show that such food products are liable to be deleterious to health ?—Subject to what I have said above, I am not aware that any authority has any such power.

Extent of advice by Local Government Board to local authorities under Sale of Food and Drugs Acts.

11513. To what extent has it been the practice of the Local Government Board to direct or advise local authorities under the Sale of Food and Drugs Act to take action regarding particular food products which it appears desirable to watch, either on account of special liability to fraudulent adulteration ; or on account of liability to be contaminated by deleterious substances, for instance, arsenic ?—On the occurrence of the arsenical beer poisoning epidemic the Board issued a circular (11th December, 1900), urging Councils of counties, boroughs, urban and rural districts to take for analysis samples of beer and other foods into whose composition glucose and other sugar substitutes entered. As a result thousands of samples were procured at the instance of local authorities, and examined by public analysts. I do not know whether a copy of that circular has been put in ; I put in a copy now.

(The Circular was handed in.)

The Board have in their annual reports from time to time called attention to the prevalence of particular forms of adulteration which have been brought to their notice in the reports of public analysts. Copies of the Board's reports are sent to all sanitary authorities. It is also the practice to send to public analysts themselves that portion of the Board's annual report which relates especially to them and to their duties. As illustrating this practice I draw attention to the following Reports :—

1879-80, p. cxiii, under the heading of "Bread Making," the Board drew attention to a report which they had received from the chemists of the Inland Revenue Department, from which there seemed to be no doubt that some descriptions of flour especially that made from Egyptian wheat, contained appreciable quantities of clay, which could not be separated by the miller. It was pointed out with reference to this report that such tests should be used as would determine whether the alumina be present in an insoluble condition as it would be if derived from earthy matter, or in a soluble form, as it would be if existing as alum. In their report for 1880-1 the Board drew attention to the fact that in some so-called "unfermented wines" sold as temperance drinks, which profess to be composed of pure grape juice, were really mixtures of tartaric or salicylic acids, sugar, and flavouring matter. Some of these also contain a dangerous amount of copper, due probably to the manufacture having been carried on in vessels of which the acids had dissolved part of the metal.

In the Report for 1886-7 attention was drawn to a trade which had recently sprung up in the sale of "Poivrette," or "Pepperette," a substance which was made in Italy by grinding olive stones, and was sold in this country at about 1d. a pound, whereas the price of the pepper with which it was mixed was from 8d. to 1s. 6d. a pound.

In the Report for 1889-90 attention was drawn to a statement in the report of the public analyst for the parish of St. George, Hanover Square, to the effect that as there was no legal definition as to

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the composition of sweets, the examination of them under the Act was confined to the search for poisonous colouring matters and flavouring materials, and for insoluble and indigestible constituents such as plaster of Paris and paraffin wax.

In the report for 1892-3 attention was called to a report made by public analysts for the West Riding of Yorkshire and Cheshire, to the effect that at that time a systematic attempt was being made to place on the English market imported butter containing an excess of water, and in some instances sophisticated with a small proportion of margarine difficult to detect and liable to escape recognition unless the butter be subjected to a very special examination. In the same Report, attention was drawn to the experience of the analyst for Cheshire with regard to the dyeing of sugar in order to make beet sugar pass as Demerara. The sugar was found to be dyed with what is called "Nicholson's blue," which is Triphenyl rosaniline sulphonic acid. In the same report, it was further pointed out that an imitation of lard which had recently been placed on the market under the name of "Lardine" had been found by the public analyst for Lancashire, to be made up either of beef fat or of the hard fat which remains when oleo-margarine is pressed out of beef fat. It was softened down by the addition of cottonseed or other cheap oil mixed with some preparation of hog fat, and prepared for market.

These are samples of the way in which the Board have utilised the experience which they have gained from the tabulation of the reports of public analysts. No duty of supplying this information has been imposed upon them. So far as I know, no information has been given to the Board with regard to the prevalence in food stuffs of such deleterious substances as arsenic prior to the occurrence of the epidemic of arsenic-poisoning which is being enquired into by this Commission.

No organised system to guide local authorities in application of Sale of Food and Drugs Acts.

11514. Is there any machinery available for guiding local authorities under the Sale of Food and Drugs Acts as to the nature of samples which should be taken, and as to the character of the adulteration or contamination to be looked for? For example, is it a recognised duty of the public analyst or of medical officers of health to give advice of this kind?—I do not think there is any organised machinery of the kind referred to. The official publications of the Society of Public Analysts are full of learning connected with the profession of public analyst, and these organs have from time to time called attention to the introduction of new forms of adulteration. Public analysts are therefore in a position to learn from the experience of one another, and I take it that in the performance of their duties they do frequently advise the inspectors appointed to collect samples as to the samples which the inspector should procure. I cannot say whether analysts as a rule advise their inspectors in this way, I only know that some analysts do it. The Sale of Food and Drugs Acts do not impose upon public analysts or upon Medical Officers of Health the duty of giving such advice to the local authorities employing them. As regards Medical Officers of Health the Board's General Order of March 23rd, 1891, requires the Medical Officer of Health to inform himself as far as practicable respecting all influences affecting or threatening to affect injuriously the public health within his district, and to enquire into and ascertain by such means as are at his disposal the causes, origin, and distribution of disease in his district, and ascertain to what extent the same have depended on conditions capable of removal or mitigation; and he must be prepared to advise his authority on all these matters (Article 18 (1) (2) (4)). Hence in the event of there occurring any adulteration or impurity or contamination of some particular article of food prejudicially affecting the health of the district, it would be his duty to act under the regulations. The regulations also provide that subject to the instructions of the sanitary authority the Medical Officer of Health shall direct or superintend the work of the inspector of nuisances in the way and to the extent that the sanitary authority shall approve. Sub-Section 8, Article 18 (Duties) provides:

In any case in which it may appear to him to be necessary or advisable, or in which he shall be so directed by the Sanitary Authority, he shall himself inspect and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk, and any other article to which the provisions of The Public Health Act, 1875, in this behalf apply, exposed for sale or deposited for the purpose of sale or of preparation for sale, and intended for the food of man, which is deemed to be diseased, or unsound, or unwholesome, or unfit for the food of man; and if he finds that such animal or article is diseased, or unsound, or unwholesome, or unfit for the food of man, he shall give such directions as may be necessary for causing the same to be dealt with by a Justice according to the provisions of the Statutes applicable to the case."

It is the duty of the Inspector of Nuisances under the regulations relating to his work to procure and submit samples of food, drink, or drugs suspected to be adulterated. The regulation is in these terms:

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"He shall from time to time, and forthwith upon complaint, visit and inspect the shops and places kept or used for the preparation or sale of butchers' meat poultry, fish, fruit, vegetables, corn, bread, flour, milk, or any other article to which the provisions of the Public Health Act, 1875, in this behalf shall apply, and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, milk, or other article as aforesaid, which may be therein; and in case any such article appear to him to be intended for the food of man, and to be unfit for such food, he shall cause the same to be seized, and take such other proceedings as may be necessary in order to have the same dealt with by a justice: Provided that in any case of doubt arising under this clause, he shall report the matter to the Medical Officer of Health, with the view of obtaining his advice thereon."

"He shall, when and as directed by the Sanitary Authority, procure and submit samples of food, drink or drugs suspected to be adulterated, to be analysed by the analyst appointed under the Sale of Food and Drugs Act 1875, and upon receiving a certificate stating that the articles of food, drink, or drugs are adulterated, cause a complaint to be made, and take the other proceedings prescribed by that Act."*

The Medical Officer of Health might thus be required by his local authority to direct the Inspector of Nuisances as to the nature of the samples to be procured by him for analysis.

Many county medical officers and many medical officers of districts as well as public analysts appear to give advice as to the nature of the samples which it is desirable should be procured for analysis. We know from the reports of Medical Officers of Health that before the Board's circular † suggesting that course was issued, many of them advised the taking of samples of various articles likely to contain arsenic.

11515. It would appear from the answer that you have given to the last question that it is not the express duty of anyone, except perhaps the Medical Officers of Health, to investigate the processes of manufacture of food products with a view to discover whether there is risk of introduction of poisonous or deleterious ingredients before the same is exposed for sale?—Except perhaps, the Medical Officers of Health, so far as I am aware that duty has not been imposed upon any person by law.

Suggested Court of Reference.

11516. Has your attention been called to the recommendation of the Departmental Committee on Food Preservatives and Colouring Matters respecting the appointment of a Court of Reference?—I have read the Report of that Committee, and I am familiar with their recommendations.

11517. Would it be practicable to prepare and publish a schedule of the preservatives or colouring matters which, after the necessary inquiry and experiment, might be regarded as likely to prove dangerous to the public health?—I think it would be possible to a certain extent, if a Court or Reference were established to settle precisely what preservatives are to be regarded as injurious and in what amounts, if any, they might be permitted to be used. The question, however, is a very difficult one. Who is to appoint the Court of Reference? What kind of body is it to be? Is it to be permanent or temporary? Are its decisions to be subject to appeal or not? These, and many other similar questions suggest themselves. Under the Sale of Food and Drugs Acts a sort of court of chemical appeal exists, consisting of the experienced chemists employed at the Government Laboratory. Attacks upon their decisions frequently have been made by other analysts of repute, their methods have been criticised, their decisions have been disputed, their knowledge has been impugned. No doubt this will all happen with regard to a Court of Reference such as was recommended by the Select Committee on Food Products Adulteration, and by the Departmental Committee on Food Preservatives. One difficulty in setting up such a Committee is to find a small number of men (and I take it the Committee must be small if it is to be effective) who will be competent to express on a variety of different questions opinions which will satisfy the scientific world generally. No doubt such a Committee, if it could be constructed,

* Corresponding provisions to these are contained in the Board's General Order relating to London. That is a separate Order, but it practically contains, so far as this matter is concerned, the same provisions.

† 11 December, 1900.

would be of material service in setting at rest some of the vexed questions which are constantly arising in the administration of the Sale of Food and Drugs Acts. Whether such a Court will or will not be set up is a matter upon which I cannot now say more than this—that the question is under the consideration of the Local Government Board.

11518. Putting aside now the question of the appointment of a Court of Reference, can you say whether any administrative authority has at the present time power to prohibit particular processes of food manufacture; for example, kilning malt with gas coke or the use of particular ingredients in food, such as arsenical sulphuric acid?—No authority, as far as I am aware, has any such power. It is to be remembered, however, that in manufacturing food, as in manufacturing other articles of commerce, the manufacturer is responsible for the article he produces. Speaking generally, it is a rule of the common law that every dealer in provisions impliedly warrants them to be wholesome and fit for food. It was laid down as long ago as the reign of King Henry VI.—"If I come to a tavern to eat and drink and the taverner gives me meat and drink corrupted whereby I am made sick, an action lies against him without any express warranty because it is a warranty in law." (Year Book 9, Henry VI, p. 53.)

There are, no doubt, limitations to a rule of this kind. Thus, even a vendor of food is not ordinarily liable for selling meat with a latent taint of which he was ignorant, and which he had no means of knowing, unless he gives a warrant that the meat is fit for human food.

11519. Would it be practicable to issue official memoranda or instructions to local authorities as to particular food products which through process of manufacture are liable to contain deleterious substances? What steps could be taken, for example, if it was decided to be necessary to protect the public against risk from arsenic to foods consisting largely of yeast?—It would be possible to take the same action in regard to any such matter as was taken by the Local Government Board in its circular of the 11th December, 1900; that is to say, it would be possible to warn local authorities that a certain dangerous ingredient had been found in a specific article of food, and to suggest to the authority that instructions should be given to its food inspector to procure samples of food of the kind in question, in order that the same might be submitted for examination to the public analyst. The difficulty in taking action of this kind in any case arises from the absence of knowledge on which to base the action. The Local Government Board have no staff whom they can employ in a roving enquiry to ascertain when any new element of danger may appear in an article of food. It would be altogether impracticable to enact, for instance, that no new article of food should be placed upon the market until its composition had been determined to the satisfaction of a Government Department. There must be some latitude to cooks and confectioners and other manufacturers of foods, artificial and otherwise, so as to enable them to prepare their respective goods for the market. You cannot give them a certificate of approval at the outset. You must, I think, be content with the responsibility that by law rests upon them of supplying a wholesome article. You might make their responsibility an absolute responsibility perhaps, though I think there would be difficulty in passing a proposal with that object through Parliament. I mean that it would be difficult to enact that the vendor of an article of food should be responsible for its wholesomeness if he did not know that it was unwholesome, and could not have ascertained that it was unwholesome by any reasonable action on his part. Parliament could, if it thought fit however, impose a liability on purveyors of food even to that extent. My suggestion is, that it would be unlikely or unwilling to do so.

11520. You have said in a previous answer "There are no doubt limitations to a rule of this kind. Thus even a vendor of food is not ordinarily liable for selling meat with a latent taint of which he was ignorant, and of which he had no means of knowing unless he gives a warranty that the meat is fit for human food." Does that mean unless he gives a special warrant?—That is so.

11521. Does not the fact of him offering it for food imply that it is fit for food?—There was an actual decision of the Court. The facts which I have given came before the High Court, and they decided that on those facts the vendor was not liable unless he gave an express warranty, the reason being, I suppose, that knowledge on his part could not be presumed. Of course, if it could be shown that the man knew that there was this taint, he would be liable, and if he could by the exercise of any reasonable action have discovered the taint, probably he would also be liable.

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11522. That seems to mitigate somewhat the severity of the law in Henry VI.'s time, by which if the keeper of a tavern offers an article for food, and a person is made sick by it, the keeper of the tavern is responsible?—Yes, I think perhaps it does.

11523. There was a very bad case a few years ago, where people died from something they ate at a first-class London hotel?—Yes, there were several cases of illness among people staying at that hotel.

11524. Is the responsible head of the hotel not responsible for such a casualty, for such a disaster, as that?—That is a very difficult question to answer. You have two decisions given in the same book pointing in different directions. The answer would depend upon the facts of the particular case.

11525. (*Professor Thorpe.*) Did not an action arise out of this particular case at the hotel?—I believe there was an action.

11526. What was the result of that action?—As far as I know it is not reported.

11527. (*Sir William Church.*) Has there been any legal decision with regard to the poisoning caused through eating pies this year at Derby?—As far as I know, not by the High Court. Whether there has been any decision in any other Court I do not know. Of course an action would lie in the County Court.

11528. (*Professor Thorpe.*) There are a number of cases in which actions have been brought against the proprietors of restaurants by various people who stated they had been made ill by the food they had eaten at restaurants. The people have claimed their doctor's fees, and some compensation?—Whatever may be the result of cases of that kind, no action can be brought by a local authority in such cases. That would be only an action at Common Law for damages sustained by the person immediately injured. No action could be taken by a local authority with a view to prevent the sale of any such deleterious ingredient as may have been found in the substances complained of at a restaurant in those circumstances.

11529. Your point is, that it is a mere process of the civil law and civil recovery?—Yes, it is a civil remedy, and therefore it is inapplicable to the circumstances which the Commission have to consider.

Present legislation essentially directed to finished product.

11530. (*Sir William Hart Dyke.*) With regard to the general policy that has governed all these Food and Drugs Acts, it appears that Parliament has invariably shirked the main question of trying to strike at the root of these dangers from poisoning or from adulteration by not applying some efforts to detect deleterious substances before the finished article was presented to the customer?—Except to the extent that I have quoted from Statute Law, that is so.

11530* Taking all these Food and Drugs Acts, they have all ended, have they not, in sampling?—Yes, sampling from goods exposed for sale or deposited for the purpose of sale.

11531. And therefore in many cases it may happen that the attention either of yourselves at the Local Government Board or the local authority is first drawn to the mischief that is going on by someone suffering severely through being poisoned, for instance, in what has been called the Manchester scare?—That is so.

11531.* You have been for many years at the Local Government Board, have you not?—Yes.

11532. How many years?—30 years.

11533. You have had a very practical experience with regard to all these matters, and have been serving a Department which has its eye on these dangers and difficulties. Speaking from your own personal experience, can you give the Commission any hint as to whether it would be safe to extend the provisions of the Sale of Food and Drugs Act further; for instance, with regard to giving powers to the officers of local authorities, whether representing the Board of Health or otherwise, to enter the manufactories, in fact, to examine articles which are about to be utilised for the purpose of food and drink?—I think there would be great difficulty in getting Parliament to consent to such powers. Parliament is jealous of giving a right of entry into private premises, where an Englishman is said to be in his

Question of legislation to enable exercise of control over food manufacturer.

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castle. If a man is selling anything, and the public have a right to go into his premises to buy, there is good ground for giving to an inspector the right of going in, and of demanding to purchase commodities which are there sold: but to give power to an inspector to go into what may be a private house for that purpose would be going further than Parliament has hitherto done. Then, if such powers were given, it is very difficult to see how they can be worked. Supposing the local inspector of food had a right to go into my house and enquire whether I was manufacturing any article of food for sale, is he to have a right of searching through my house? Is he to have a right of examining every food stuff or ingredient that may be manufactured into food, and if so, is he to take anything that he chooses, whether it is for sale or not, whether it is there for experiment or not? Is he to seize and take away anything and examine it? And supposing he takes it away and examines it, and ascertains that any particular ingredient is of a poisonous nature, how is he to be able to say that that was going to be used for food? Is he to charge me, the manufacturer of a food stuff, with an offence because I have on my premises an article which, if used for food, might be dangerous to a person consuming that food? I suggest these points as points of difficulty which would be found to arise if Parliament were to give power to enter and examine any ingredients that may happen to be found in a private house. With regard to those cases which I have quoted, take for instance, margarine, a more extended power is given to inspectors. Margarine is a substance that has been fraudulently sold for butter, and, in giving a vendor power to sell margarine in a condition which the ordinary public might not distinguish from butter, Parliament has accompanied that gift by the condition that the vendor shall be subject to somewhat extended powers of examination by the food inspector.

11534. There are special circumstances in regard to margarine, and its connection with butter, which enable Parliament to deal more strigently in that case than they generally do in regard to other manufactures?—That is so. I think that also applies to the case of the sale of horse-flesh. Horse-flesh has been fraudulently sold as ordinary meat; and in licensing houses where horse-flesh may be sold, the local authority may give that licence subject to certain conditions. There again, there are special circumstances which have enabled Parliament to give extended powers of entry and search which do not apply, I submit, in the case of ordinary food ingredients.

11535. Of course it is merely common sense to say that it is to the interest of the trader in every case to poison his customers as little as possible, but even if that is so, there must be danger, must there not? For instance, take the case of the manufacture of glucose, the terrible results of which were the cause of the forming of this Commission; and there must be other cases where carelessness of a gross nature, such as that, has resulted in great loss of life?—Yes.

11536. You agree, do you not, that some means ought to be devised, if possible, to prevent such a thing happening again?—I agree that it is desirable to apply a remedy, if a remedy can be found which is not worse than the offence.

Relation of Local Government Board to administration of Sale of Food and Drugs Acts.

11537. Will you tell us a little more with regard to the position that you, as the Central Department of the State, occupy with regard to the local authorities, not so much on the general health question, but more especially with regard to the taking of samples, which appears to be the chief and leading protection to the British public. You have referred to cases, have you not, where you analysed certain samples, and then sent the results of your labours to the local authorities. In what kind of case does that arise? Is it customary, when you find there is neglect on the part of the local authorities, for you to step in, or what is the precise relationship in that regard between yourselves and the local authorities?—The Board have no power to analyse samples themselves, and have never done so. We have no chemical officers working under the Sale of Food and Drugs Acts. We only get our knowledge from the reports that are sent to us under Section 19 of the Act of 1875. When we find in those reports any indication that may apparently be useful to public analysts generally, that is mentioned in the annual Report which the Board makes to Parliament, copies of which are sent to the local authorities. As I have already said, until the Act of 1899 was passed, the Board's position in the matter was a very small one. The Board had no powers whatever. The Act said that copies of certain quarterly reports were to be sent to them. That was done, but there was nothing in any Act requiring the Board to take any action. These reports were originally received and tabulated, I think, in the year 1877, and from that time down to the present they have been tabulated, carefully examined, and letters have been frequently written to local authorities charged with the administration of the Acts. It has been pointed out to them that they should do more if they did not do enough, and generally the Board have done as much as they possibly could by exhortation, to get local authorities to put in force these Acts.

11538. This stimulating process goes on from headquarters as regards the local authorities, upon reports received by you?—Yes, that is so.

11539. And if you find there is anything like slackness, you put pressure on, so as to secure better local administration?—Yes.

11540. After this calamity from beer poisoning, you took steps, did you not, to procure something like a wholesale analysis?—Yes, we had the power given to us under the Act of 1899.

11541. You took advantage of that power?—We took advantage of that power to issue the circular which I have put in, asking local authorities to cause samples to be examined of the various ingredients in which arsenic might possibly be contained. Of course it is practicable to do that in any other similar case; the difficulty arises in knowing where to begin, or in what particular case such action is necessary.

Court of Reference.

11542. Mention has been made with regard to the report of this Committee on Food Products Adulteration, and to the recommendation of a specially constituted scientific body as a Court of Reference. In regard to that matter I should like you to give the Commission your views with reference to either the establishment of a Board of Reference such as that, or of some small expert Sub-Department of the Local Government Board?—I have said in my evidence in chief that I think it would be practicable to appoint such a Committee. There are many difficulties in the way, and when the question arose in the House of Commons during the passing of the Bill for the Sale of Food and Drugs Act, 1899, a motion was made by Sir Charles Cameron to insert a particular clause. That particular clause was opposed by Mr. Walter Long, who was then President of the Board of Agriculture, for certain reasons that he gave. That being so, I, as an officer of the Local Government Board, have some hesitation in expressing any view as to the establishment of a Court of Reference.

11543. But surely if Parliament is in difficulty with regard to the protection of the public in such a case as that which has occurred with regard to the wholesale beer poisoning—if Parliament can go no further than this process of sampling which now goes on; if Parliament is unable to suggest a further remedy—does not common-sense rather indicate that a kind of sub-committee of experts connected with a Board such as yours, watching any symptom of danger, carefully examining all reports that may be received—that a body like that, although Parliament has not given extended powers, might yet give an early note of warning in such a case as that which has occurred, which might have the effect of saving life, misery, and disaster?—If I may give my personal view in the matter, I think that the establishment of a Court of Reference such as was suggested might effect the end which the Commission have in view. It would be useful to ascertain from time to time when new chemical substances are employed as ingredients or as colouring matters, or as preservatives for food, whether there is likely to be any harm in the use of any such substance. If the question could be referred to a competent committee of experts, it would be practicable for something to be done to protect the public against the use of any such injurious ingredients. But one difficulty, if you have such a committee as was suggested by Sir Charles Cameron—I am speaking from memory—is this, that the committee would be irresponsible, and I doubt whether Parliament would agree to give to an irresponsible committee powers, practically legislative powers, which would enable the committee to say in regard to any particular article, "That article shall not be used in the composition of food." That power might, however, be given to a Government Department, because the chief of the Government Department would be responsible to Parliament, and any order that he might make in the matter would be subject to review in Parliament. The

Local Government Board have no officers who could do this, and it would be better, I should think, to suggest that a separate committee should report to the Local Government Board on the subject than that the Committee should make any order themselves. If, therefore, a Court of Reference were set up, with powers to examine any food ingredient that might be referred to them—we will say by the Board of Agriculture, or by the Board of Trade, or by the Local Government Board, —if powers were given to them to report on that article to the Government Department concerned, and that department were empowered to make an order on the subject, I think this would help to remedy the grievances which at present exist.

11544. You think that this body should have statutory powers, do you not? That is to say, it should be able to communicate at once to the local authorities where any mischief might be going on, in a factory or in other places, through the sale of any article manufactured in a particular way?—No, I should not suggest that they should have statutory powers.

11545. I am afraid I misunderstood you, then?—I suggest that they should report to a Government Department. The action which you suggest would be an administrative action. They should be merely a scientific body, declaring whether or not a specific article referred to them for report is or is not a dangerous ingredient. Assuming that that report were made to the Local Government Board, my suggestion is, that the Local Government Board would have the administrative power necessary to warn local authorities, and through them public analysts, as to the possibility that such an article might be used.

11546. I am glad you have made that clear. As far as the statutory power is concerned, that, of course, should be Departmental, should it not?—I think so.

11547. (*Sir William Church.*) There are one or two points I should like to refer to, which I did not quite follow. In answer to a question stating that it was not the express duty of anyone to investigate processes of manufacture of food products with a view to discover whether there is risk of introduction of poisonous or deleterious ingredients before the same is exposed for sale, you replied, "So far as I am aware that duty has not been imposed upon any person by law," and then you said, "Unless it came within the province of the Medical Officer of Health"?—The Medical Officer of Health's duty is what I read from the General Order relating to Medical Officers of Health. It is the duty of a Medical Officer of Health "To inform himself as far as practicable respecting all influences affecting or threatening to affect injuriously the public health within the district. He shall inquire into, and ascertain by such means as are at his disposal, the causes, origin, and distribution of diseases within the district, and ascertain to what extent the same may have depended on conditions capable of removal or mitigation." It may possibly be argued that in an instance like the beer poisoning cases in the North, it was the duty of the Medical Officer of Health, knowing that a death had occurred in some mysterious way, and that other similar deaths had followed it, to have investigated the causes and origin of the diseases which led to those deaths.

11548. That leads me to this: Supposing a Medical Officer of Health came to a conclusion, right or wrong, that certain cases of illness, we will say among children, arose from their consuming sweets made by a certain person; am I to understand from you that you think he would have the right of entry upon the premises to see what was going on on the premises where those sweets were made?—No; I am quite clear that he would not have any such right. I do not think, myself, it is the duty, in such a case as that, of the Medical Officer of Health under this Order to go to that extent.

11549. Supposing he went to his sanitary authority, would that sanitary authority have power to order their Inspector to go to those premises?—No. The only thing they could do would be to order their Inspector to take samples of those sweets at shops where those sweets were sold.

11550. That leads me to another point that I should like some information on. Supposing a person manufactures a food product of any sort or kind, sausages or patent meal, or whatever it may be, and sets up machinery for doing so in his own house; that machinery is inspected, and he is liable to see that it is properly guarded?—That is under the Factory Acts.

11551. But is not that a case where a man's castle is invaded?—Yes, for the purpose of seeing that the worker is properly protected in the course of his work, but that is not intended to protect the public at all.

11552. Although there is no existing machinery now for seeing that the buyer is properly protected, do not you think that that is an analagous case? There would be no hardship in premises being inspected to see that the buyer was not prejudicially affected as well as the worker?—I submit that there is a difference in principle between an enactment authorising the inspection of premises to see that machinery on those premises may be safely used by factory workers, and one authorising the inspection of premises where food stuffs are manufactured with the object of taking away for analysis ingredients that may be found on the premises. In the latter case the object of the inspection is not to protect the workers but to protect the public.

11553. No doubt; but I do not see that there would be a greater infringement of the rights of the individual?—It is for the Commission to judge. My own view is that there is a difference between a case where machinery is used—dangerous machinery be it presumed—and a case where a man carries on, say, the making of bread without machinery in a private house.

11554. At the present moment, apparently, the law has never been repealed which applies to millers and bakers?—That is so.

11555. Therefore it would only be an extension of that to the premises of people who manufacture food products, of any sort?—That is so, and it was expressly because there was to that extent a precedent that I quoted the case to the Commission.

11556. Therefore, if you think there is this difficulty in obtaining the materials of which food products are made in the premises, you would also object to their being stopped on transit to those premises?—It is not that I should object.

11557. You think there would be difficulties in stopping them in transit to the premises?—I think the principles by which Parliament is usually guided in this case would apply. Parliament, so far as my observation of legislation is concerned, is very jealous of increasing the power of any local authority to enter private premises. One sees that in legislation generally.

11558. I think I understood you to say that milk in transit between the producer and the distributer may be stopped, and samples taken?—At railway stations.

11559. Only at railway stations?—Practically only at railway stations.

Object of law as to sampling in transit.

11560. Not on the road?—The object of that enactment was this. A great deal of milk is brought from the country by railway to London. Samples were taken at shops, and it was found that the milk was adulterated. The allegation was made that the milk had been adulterated before it reached the retail vendor's shop. Then an effort was made to protect the retailer by giving power to take samples at the railway station.

11561. That is a special case which you think is not applicable here?—That was extended by the Act of 1899 to all other articles, provided the consignee or the purchaser requested that such examination might be made. The object of that is again to protect the retailer against the wholesale vendor. The retailer says: "I sold the thing as I received it; the vendor to me must have been guilty; I have no means of ascertaining whether he was or not." Parliament says, "Then, at your request, you may during the transit of that article to you cause an examination to be made by the food inspector."

11562. Take a somewhat similar case. In the case of jam factories, is it not the fact that fruit going into those factories may be seized if it is found in a decomposing condition?—That has been done, no doubt.

11563. Under what power was that done?—That was done under the Public Health, London, Act. The fruit was, I suppose, deposited for sale, or for preparation for sale.

11564. Could not that Act be extended in such a way that samples of materials could be taken in the food factories?—I think it could.

Question of sampling at factory.

11565. Could not it be so extended that it would be in the power of an Inspector to take a sample of sulphuric acid on its way to a glucose factory?—Once having established, in the ordinary course, that an article like glucose is likely to contain a poisonous ingredient, it

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might be possible to schedule that particular article as a dangerous one which the Food Inspector might have special powers of examining.

11566. You mean, you would have no power to examine anything excepting scheduled articles?—You clearly could not examine under the Sale of Food and Drugs Act such an article as sulphuric acid except as a drug; it is not a food.

11567. (*Professor Thorpe.*) Anything which enters into the composition of a food is a food under the Act of 1899. To the extent to which oil of vitriol enters into the manufacture of food, or is ancillary to it, it is a food?—I do not know that sulphuric acid is an article that enters into the manufacture of food.

11568. (*Sir William Church.*) I would like to put this instance before you. We have had evidence given here that a man started a food factory—I do not know that he patented it—of a food which he made out of brewers' yeast, to a great extent, and malt culms. Could not power be extended so that those substances might be sampled upon the way to his factory?—It could, of course, be done.

11569. Would it be impossible, or do you think it would give rise to great difficulty, if some extension of power was given to the inspection of food factories, which are, of course, distinct from a private house in a village, where an old woman makes a few tarts to sell to children; would there be any objection, where anything in the nature of a wholesale factory is put up, to its being under Government inspection—it is under Government inspection for the Factory Act now?—Yes, for another purpose. I was thinking of the difficulty the Government Department would be in if it had such a responsibility cast upon it. If a Government Department is to be responsible practically for all the ingredients that enter into the composition of food it would want a very large staff to deal with the matter.

11570. But could it not be done by the Local Authority in the same way that now a sample of the finished product can be obtained from the retailer so the Local Authority's officer might have power to go into the factory and ask for samples of the *material* used in the production of the food?—Parliament could give such a power.

11571. That would not throw the greater amount of work, or not much work, upon the Central Board, the Local Government Board?—It would be practicable to give such a power to the officer of the Local Authority. My difficulty rather is to know how that would be worked in practice. An inspector of food would go into a factory and would take, we will say, sulphuric acid. It is known now that certain of those ingredients contain minute portions of arsenic. That was discovered, I presume, by accident.

11572. No, I do not think by accident?—My difficulty is, is there any known way of ascertaining whether or not a particular ingredient such, we will say, as sulphuric acid, contains a poison without examining that sample for every known poison, and using every known test that science is acquainted with.

11573. That applies to any analysis, the analysis of all food. The public analyst, for instance, who analyses milk, only analyses to see whether there is an undue amount of water in it; he does not analyse to see whether there is hydrocyanic acid in it. That applies to all analyses equally?—That is my point.

11574. An inspector might go into a food factory, take samples, and send them to the analyst of the body whom he represented, and say: "That is used in the production of food, does it contain anything which is obviously deleterious?" It might contain some unusual poisonous material, which would escape observation until some accident led to its discovery, and that is the case with all food?—That is so. It would no doubt be possible for Parliament to give such powers, but whether administratively those powers would result in the discovery, for instance, of such an ingredient as arsenic I very much doubt.

11575. But it would, at all events, give this protection to the public, that it would be known what the constituents of these prepared foods are. At the present moment, as far as I understand, it is open to anybody to set up a factory and turn out what he calls a food, or protein or give it what name he likes. Nobody knows in the least of what it is composed, and it would be a great safeguard to the public if a sanitary authority could investigate and know what those foods are?—It would be possible to enact that a local authority should have the power of ascertaining the nature of the work that was carried on at any such factory as you suggest. Of course in patent processes—and some of those processes, I suppose, are patented—the patentee is obliged to disclose, before he gets his patent, what he puts into his commodity.

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Patent foods.

11576. That would be the guide for the analyst?—Perhaps there would be no greater difficulty in requiring that a man who sells an article of food should declare its ingredients than there is in requiring that a man who has a patented article should declare beforehand by a specification what that article contains, and how it is made.

11577. And it would be seen then whether he continued his manufacture under the terms of his patent?—Yes, the principle on which the declaration of the protection of a patented article rests is, I suppose, that others may sell it after a certain time has elapsed. The requirement of a declaration of the ingredients of manufactured foodstuffs might perhaps be defended as necessary to protect the public health.

11578. The Patent Office offers no opinion as to whether the food patented is likely to be wholesome or not?—No.

11579. But the Sanitary Authority would?—Yes.

Powers of Medical Officers of Health at place of food manufacture.

11580. (*Professor Thorpe.*) I should like to have made a little clearer what your opinion is as to the exact limitations of the power of Medical Officers of Health. I will put a case to you which actually happened, and I should like to have your opinion as to whether the Medical Officer of Health went beyond his competency. A certain ingredient entering into the composition of beer was found to contain a large quantity of a noxious substance. It was found that this substance was compounded by a druggist who had, in addition to his retail establishment, a considerable manufacturing establishment, making articles to be distributed wholesale. The local authority was informed of the fact; their Medical Officer of Health went to this shop and asked to be given a sample. The person in the shop declared that he had no more of the article; he did not refuse to sell, because, had he refused to sell, he would at once have been amenable. But what he did say was, "I happen to have no more of the substance." The Medical Officer of Health had no means of knowing whether he had or had not, but he took it upon himself to go into the manufacturing premises, and actually took samples of various materials which entered into the composition of that material, and brought them away and had them examined. Do you think he acted *ultra vires*?—Certainly. I should think he would be liable to an action for trespass.

11581. When he was asked if he could do it, he himself expressed his own conviction that it was within his competency, and therefore he did it and took away the samples?

(*Chairman.*) Was he pulled up for doing it?

(*Professor Thorpe.*) No.

There is nothing like boldness in such a case. I should like to ask you whether the Medical Officer of Health had permission to go in. If he had permission to go in, and had permission to take these things, then no action would lie against him. If I go into a private house and say, "Will you give me a sample of that sugar and this jam," and samples are given to me accordingly, I have a right to take them away, but I have no right to demand those samples, nor had the Medical Officer of Health any right to demand to take those ingredients.

11582. To what extent it was an act of grace on the part of the proprietor to allow him to do those things I cannot really determine because I was not present; I only got the information second hand. The samples came to me, I may say, eventually, and were examined by me. We at the Inland Revenue set this action in motion; we could not do it ourselves, except through the Local Authority. The Local Authority, the Medical Officer of Health of the Sanitary Authority, in particular towns, does not seem to have any misgiving as to what he may do?—I am quite aware that sanitary officers are often welcome where they have no right, and are allowed to do things which by law they cannot claim to do. I think the case you have quoted must be such a case.

11583. Your point is that this man, unless he were allowed to do so, acted *ultra vires*?—I have no doubt about it.

11584. With reference to the numerical details you have given us as to the samples taken, was the great

majority of these samples milks and butter?—That is so.

11585. They are not articles really into which any deleterious ingredient is likely to enter?—Not such an ingredient as arsenic.

11586. The object of taking those samples is to protect the consumer, in order to see that he gets milk which has the amount of fat in it and other nutritive ingredients as defined by the regulations of the Board of Agriculture?—That is so. The very considerable extension in the number of samples taken and examined during the year 1901 was no doubt due, to some extent, to the circular of the Local Government Board, and to the scare caused by the deaths and illnesses from beer poisoning. I have here an abstract of the reports of public analysts for the year 1901. If you wish, I will read the actual numbers that were examined and the various food stuffs, taken under the Sale of Food and Drugs Act.

11587. Of 100 samples of food analysed, what proportion were milk and what proportion were butter; is that given in the tabular return?—No, this is the percentage of adulteration.

11588. My point is this. Articles which are supposed to, or which may, contain deleterious ingredients are not very extensively sampled as compared with articles like milk and butter where the allegation is that the milk is watered or deprived of a little fat, or that the butter may be mixed with a certain amount of foreign fat which, of itself, is not noxious, but which merely constitutes a fraud upon the person?—That is true. In 1901 there were altogether 67,841 samples examined. Of these samples, 26,143 consisted of milk, 11,938 of butter, 5,068 spirits, 3,960 beer, 2,824 of confectionery and jams, 2,301 of drugs, 836 of sugar, 691 of mustard, 587 of flour, 530 bread, 463 tea, 52 wine, 1,883 coffee, 1,655 pepper, 1,374 lard, and 7,536 other articles.

11589. But the general effect of this is that these articles were examined not so much as containing possible deleterious articles as that they might be impoverished, or that they might be objects of a less valuable character than what they are represented to be: that was the reason they were taken, was it not?—I do not know to what extent value enters into the ideas of those who promote examination of food and drugs locally; the main idea is, are they or are they not sold in a pure state.

11590. Take the question of spirits?—The question of spirits mainly depends on whether the spirits are or are not watered unduly.

11591. Whether they are of the legal strength?—That is so.

11592. What is your impression that samples of lard are usually taken for? The question of whether or not lard contains water is one reason why the samples are taken. Another reason is whether it is in fact lard or not, whether it is not some other fat.

11593. Is it not rather the fact that it contains a small quantity of beef stearine?—That is what I mean by another fat.

11594. In the case of pepper, is not the real reason for taking samples to see whether it does not contain adventitious matters, such as olive stones, or an undue amount of sand, or something of that kind?—That is so. I do not suppose the Food Inspector considers very much whether the particular article he is going to sample is of greater or less value than it ought to be. He says, "My duty is to take samples of foods and drugs: I have taken so many samples of butter, now I will take some samples of jam, and see if Mr. So-and-so's goods are adulterated or not."

11595. With regard to jam, that perhaps is one of the very few things which are taken with a view of ascertaining whether there are deleterious ingredients. What is searched for in jam is an undue quantity of salicylic acid, which is, to some extent, an injurious constituent—to see whether a preservative of a somewhat deleterious character is not present. That is the main object of the jam analysis, together with finding out whether it may not be coloured with some deleterious colouring matter such as an aniline dye?—Or whether it does consist of the fruit it purports to contain; for instance whether marmalade is made of turnips or whether it is made from oranges.

11596. (*Dr. Whitelegge.*) I have a few figures showing the number of samples taken for the three years 1899, 1900, and 1901. You have given us some figures for 1901, including those for confectionery and beer. I suppose you would agree that a great deal of the increase in the number of the samples of those articles was due to what happened at Manchester, and to the circular of the Local Government Board?—I have no doubt that is so.

Increase in samples since 1899 also due to arsenic question.

11597. I find, for instance, with regard to beer, that whereas only 239 samples were taken in 1899 they had risen in 1900 to 4,559 and in 1901 to 3,960. Then, for confectionery and jam the numbers were in the three consecutive years, 511, 1,547 and 2,824. Those you regard probably as more or less of a temporary increase?—Yes, I think so.

11598. Although the Board in its Annual Reports expressed satisfaction at the considerable increase which has occurred in recent years, at the same time a very great deal of that increase is due to this one local circumstance?—And I think possibly also to the fact that the Act of 1899 for the first time imposes on local authorities the duty of sampling foods.

11599. The number of samples of coffee has not increased, and there is no increase in the number of samples of lard. Looking at these figures, it seems to me that the increase is mainly, at all events most conspicuously, in regard to those things that have to do with arsenic and the recent enquiry?—I quite agree.

11600. You have mentioned that the Board have no staff to make technical enquiry into these matters; some enquiry was made by the Board, I think, after the Manchester arsenic epidemic, was it not?—A medical rather than a chemical enquiry.

11601. There was no chemical enquiry made?—No chemical enquiry, so far as I know.

Facilities for inspection given to officers of Government Departments.

11602. I suppose no difficulties in regard to the right of entry arise in the case of Officers of the Board?—Facilities are generally given to the Officers of the Board over and above what they are entitled to demand.

11603. That is true throughout all the Government Departments; that is the general experience?—I think so.

11604. So that the difficulties you are anticipating with regard to inspection, the objection on the part of the manufacturer would extend to local inspection rather than to central inspection, I take it?—I think so.

Objections to inspection of food factories by officers of local authorities.

11605. And that would be increased if the right of inspection of Local Officers extended not only to the officer of the district in which the factory was situated but to the officer of any district in which the goods produced in that factory were consumed?—Clearly. Under existing law, the officer of a District Council would have no right to go outside his district for the purpose of obtaining a sample. It was decided in the High Court quite recently, that an officer has no right to take a sample at a railway station outside his own district. So that if a retailer of milk in Kensington got the Kensington Inspector to go to St. Pancras and there examine a can of milk, the Inspector could not take proceedings in respect of the adulterated sample he might have got from that can of milk, because he is a Kensington Inspector, and the place of examination or delivery is St. Pancras.

11606. We have been considering this morning, the further question of power to take samples in a factory, which does not exist now. If that were given and exercised, I suppose you would say that the difficulty would be greater in the case of local inspection by sanitary officers than by Government inspection, and greater still if more than one local authority had the power to send its officers there?—I think that is so, judging from the experience which we have had in regard to the enquiries by Medical Officers of Health in cases of tuberculosis in cows supplying milk to distant towns. Some local Acts, for instance, have given power to the Medical Officer of Health of an urban district after certain formalities have been carried out, to go to the country place and examine the cows supplying the milk to the urban district. Rural District Councils have resented the invasion, as they call it, by the City Medical Officer of Health; they have resented the fact that power has been given to a distant officer to come into their district to examine into matters with which they are concerned.

11607. That is a power which has been given in many recent local Acts, has it not?—In several cases, yes, but it is still, I may say, a matter of Parliamentary fight. There is no general enactment to that effect.

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Present powers of Medical Officer of Health and local authority as to arsenical food.

11608. With regard to the power of the Medical Officer of Health, I should like to take a particular instance which has been before us of beer in breweries. The Medical Officer of Health in a town in which beer is brewed as well as consumed, has reason to suppose that beer manufactured in that brewery, and that certain ingredients which go into the beer, contain arsenic; I gather from what you told us, that you think he has no right of entry to that factory, that if he goes to that factory he could not demand samples under the Sale of Food and Drugs Act, because the sale is not by retail?—Because there is no sale at the factory.

11609. The retail difficulty does not arise in any action that might be open to him under the Public Health Acts; is not that so?—Yes.

11610. That is wholesale or retail indifferently?—It has been so held. But it must be a place of sale. The fact that a man sells sugar wholesale does not entitle me to go into his wholesale warehouse to take a sample unless, perhaps, people are in the habit of going to those premises to purchase articles. Sometimes this happens: a man has a retail shop, and there he sells goods. I go to that shop, and I claim to buy a pound of sugar. The food inspector may go to that shop and sample the sugar and other articles that he finds there, but that would not give him the right of going to a factory half a mile away or going to a warehouse half a mile away, and demanding to be served there from samples of sugar that he saw in that warehouse.

11611. I quite follow, under the Sale of Food and Drugs Act. But under the Public Health Act, I gather from you there would be no power for the Sanitary Inspector or the Medical Officer of Health to do anything in a brewery; he could not, for example, lay an embargo on a particular lot of glucose or finished beer, pending analysis?—He could not.

11612. As a matter of fact, as you have told us, a great deal is done beyond what the law requires: for instance, the brewers in many cases destroyed their beer. But as a matter of legal right that is your view?—Yes.

11613. I want now to take another case. The Medical Officer of Health or the Inspector goes to a retail beershop and takes a sample of beer which, on the report of the analyst, is found to contain arsenic. Until he receives the report of the analyst he can do nothing under either Act, can he?—That is so.

11614. He can lay no embargo on the beer; he cannot seize the beer or do anything else?—That is so.

11615. So that when the report of the analyst comes, which is usually not for some little time, the beer may have gone, and there will be no responsibility in regard to it by those who sell it in the interim?—Presumably that is so.

11616. I am assuming that the analyst finds there is a considerable proportion of arsenic. The Local Authority take proceedings against the vendor. Must they necessarily take proceedings against the vendor in the first place, or could they go to the brewer if they think the brewer is responsible?—They could not go to the brewer.

11617. They must take proceedings against the vendor first?—Yes.

11618. If the vendor puts in a warranty, or something akin to a warranty, from the brewer, and it complies with the necessary conditions, he is entitled to his discharge on that score, is he not?—The retailer?

11619. Yes?—Yes.

11620. What is the position of the local authority as regards the brewer or the person who gives the warranty? What can they proceed against him for—for a false warranty?—No; they can only proceed against him under the Sale of Foods and Drugs Acts, 1875 or 1879. They cannot bring anything in the nature of an action against the brewer, that is to say, a civil action for damages.

11621. Proceed against him for what—for selling beer which is contaminated with arsenic, or for giving a warranty saying the beer is free from arsenic when it is not?—The offence would be selling beer contrary to the provisions of that particular statute. The retailer is prosecuted for selling beer which is not of the nature, substance, and quality demanded. He makes a good defence, the defence of warranty; then the warrantor may be proceeded against, if the conditions of the statute can be complied with, but I do not think I can give any more detailed answer with regard to that question.

Difficulties of proceedings in cases where defence of warranty is set up.

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11622. I will not press that further?—I would like to point out to you that the requirements of the statutes are very exacting. You have to comply with those requirements literally, and several cases have broken down which have been taken against the warrantor. For instance, the proceeding must be taken within six months of the warranty being given, so that, although, I suppose, beer may be kept for two or three years—I do not know how long it is, in fact, kept—yet if the publican warranted a cask of beer, and the retailer did not sell any of it until more than six months after the warranty were given, that would be a bar against proceedings against the warrantor.

11623. In any case, it will be an essential to any further proceedings the local authority may take against the warrantor that he shall be proved to the satisfaction of the Court before which the case comes to have supplied beer containing arsenic; that will be part of the false warranty, or whatever it is called?—I do not know that I quite follow you there.

11624. Let me go one step further. When the case comes on against the warrantor later in the day, is he not entitled to plead some sort of grievance in that, although he is accused of having made and sold beer containing arsenic, he has not been allowed any of the protection which the Act provides so carefully for the retailer; he is not allowed a sample, he is not allowed the power of reference to the Government analyst, and he is not informed of it technically until later on, when he cannot make any counter analysis on his own account?—Yes, a defence of that kind would probably succeed.

11625. And a defence of that kind is usually set up, is it not?—Yes, I believe it is.

Suggested association of warrantor in the defence.

11626. Is there any power under the Sale of Food and Drugs Act to associate the warrantor with the retailer, where it is proposed to rely upon the warranty? It may be within your knowledge that in the Factory Acts there is power to do that. If an employer is summoned, and he says that not he, but some person in his employment is responsible, for instance, a foreman, he is allowed to require that that person be brought to the Court, so that, supposing an offence has been committed, one or other can be convicted. Is there anything of that kind under the Sale of Food and Drugs Act?—Perhaps I may be allowed to read section 25 of the Act of 1875. It says: "If the defendant in any prosecution under this Act prove, to the satisfaction of the Justices or Court, that he had purchased an article in question as the same in nature, substance, and quality as that demanded of him by the prosecutor, and with a written warranty to that effect, that he had no reason to believe at the time when he sold it that the article was otherwise, and that he sold it in the same state as when he purchased it, he shall be discharged from the prosecution, but shall be liable to pay the costs incurred by the prosecutor, unless he shall have given due notice to him that he will rely on the above defence." That was modified by the Act of 1899 in this way. Section 20 provides "A warranty or invoice shall not be available as a defence to any proceeding under the Sale of Food and Drugs Act unless the defendant has, within seven days after service of the summons, sent to the purchaser a copy of such warranty or invoice with a written notice stating that he intends to reply on the warranty or invoice, and specifying the name and address of the person from whom he received it, and has also sent a like notice of his intention to such person. (2) The person by whom such warranty or invoice is alleged to have been given, shall be entitled to appear at the hearing, and to give evidence, and the Court may, if it thinks fit, adjourn the hearing to enable him to do so. (3) A warranty or invoice given by a person resident outside the United Kingdom shall not be available as a defence to any proceeding under the Sale of Food and Drugs Act, unless the defendant proves that he had taken reasonable steps to ascertain, and did, in fact, believe in the accuracy of the statement contained in the warranty or invoice." Some other provisions follow, and then sub-section 6 is to this effect: "Every person who, in respect to an article of food or drug sold by him as principal or agent, gives to the purchaser a false warranty in writing, shall be liable on summary conviction, for the first offence, to a fine not exceeding £20, for the second offence to a fine not exceeding £50, and for any subsequent offence to a fine not exceeding £100, unless he proves to the satisfaction of the Court that when he gave the warranty he had reason to believe that the statements or descriptions contained therein were

true." That last part slightly modifies the law as it was under the Act of 1875. Under the Act of 1875, he had to prove "That he had no reason to believe at the time when he sold it that the article was otherwise." Under the Act of 1899 he is liable, "unless he proves to the satisfaction of the Court that when he gave the warranty he had reason to believe that the statements or descriptions contained therein were true." In principle, there is a considerable difference between those two positions; in practice I do not think there is much, because it was almost impossible for the prosecution to prove under the Act of 1875 that the vendor "had no reason to believe," and now, under the Act of 1899, it is very easy for the vendor to prove that when he gave the warranty "he had reason to believe that the statements or descriptions contained therein were true." He only has to go into the box and say so, whereas, for the other side to bring contradicting evidence is, as you see, almost impossible. Therefore, although there is a difference in principle between those two provisions, the advantage to the prosecutor is not great.

11627. Supposing the person who is summoned on the false warranty could prove that the arsenic came in through some ingredient, respecting which he had a warranty from some other person outside, that would be amply sufficient to discharge him, so far as that Court was concerned, would it not?—I should think so.

11628. And under that Act, at all events, the local authority could not follow up the further warranty at all.—Certainly not.

11629. I want to ask one or two further questions about the reports of the analysts. They are quarterly reports, are they not?—Yes.

11630. Why are they quarterly, instead of annual; is any point gained by that?—I do not know why the Act of 1875 required them to be made quarterly, but, as a matter of fact, it does. These reports are required to be sent in every quarter to the local authority, and then, once a year, the four quarterly reports of the preceding year are sent to the Local Government Board. So that the local authority would have its reports of work done, we will say, from January to Lady Day, presented to it in April, but it would not reach the Local Government Board until the following January.

11631. Those four together make up the annual report?—Yes.

11632. The Board have laid down certain standards for reports of analysts; you gave us the particulars that are asked for now?—Yes. The Act itself simply authorises the Board to provide a form in which the reports shall be sent to the Board. That form was prescribed in the letter which I have put in. It is the fact that the reports made by the public analysts in 1877 and the early years of the operation of the Act of 1875 were on no common basis. It was impossible to accurately tabulate those reports, and for that reason the Local Government Board suggested the form which I have put in. They suggested it, they did not prescribe it.

11633. But, practically, there is a substantial acceptance of it by analysts?—It has been generally accepted, nobody has disputed it. I point that out, because my suggestion is that there is a difference between prescribing and suggesting.

11634. There is no suggestion made of a statement of what was looked for in the case of any particular sample?—None.

11635. For example, looking at the number of samples of beer taken six or seven years ago, and looking at those for last year, we should find an enormous increase, but in one case they would be examined for things in general?—For salt, mainly.

11636. And the recent ones would be examined for arsenic, but in neither case would the fact of the substance for which the search was made be stated?—That is so.

11637. Has any attempt been made by the Board to differentiate in a particular instance of this kind? It has been suggested that analysts might say how much arsenic they found in a sample of beer; would that appear naturally in the report itself?—The practice of analysts varies. Many analysts give the actual results of their analyses. Some say, "Genuine," or "Adulterated," and nothing more.

11638. The word "genuine" is usual?—It is.

11639. That means that whatever the foreign substances, be they many or few, that the analyst has looked for, he has not found them?—Quite so.

11640. So that "genuine" five years ago would be consistent with a high proportion of arsenic in beer?—That may very well be.

11641. With regard to the number of samples taken, they have increased, and I think it is perhaps very largely in consequence of the arsenic question. But is not there a further consideration? Is it not important to look beyond the mere number? Is it not important to look, also, to the kind of samples taken? For example, in an agricultural district—or, perhaps, rather, in a borough—there might be a large proportion of milk samples taken, while it may be that other branches equally necessary are left aside?—It may be.

11642. The Board have not reminded local authorities of default in particular kinds of sampling?—The Board have no information on which to base pressure on local authorities with regard to particular articles.

Local Government Board have no information on which to recommend sampling of particular articles.

11643. But you exercise pressure, do you not? If you find the gross numbers fall below a certain proportion of population, in such a case you do send a reminder to the local authority, do you not?—In such a case we write to the local authority, inviting their attention to the provisions of the Act, and since 1900 we have pointed out the requirements of the Act of 1899; but we have no information at present which would enable us to say: "You ought to examine butter, or you ought to examine lard, or you ought to examine any particular substance."

11644. I quite follow you; but if the reports of the analysts show that a particular local authority had not taken a single sample of milk, would that be a thing which the Board would attend to?—That we should leave now to the Board of Agriculture. I may state that the Board of Agriculture are sending inspectors round, or have been sending inspectors round, to point out to local authorities their duty under the Act of 1899, and to induce them to take samples with regard to agricultural produce.

11645. That is shown in the number of analyses here; the milk samples have gone up from 21,964 in 1899, to 26,143 in 1901?—That is, no doubt, due to the action taken by the Board of Agriculture. The Commission will remember that this Act of 1899 was introduced, not by the President of the Local Government Board, but by the President of the Board of Agriculture.

Recent increase in milk samples under Sale of Food and Drugs Acts due to pressure by Board of Agriculture.

11646. The annual report of the Board is sent to the local authority, I think you told us?—Yes.

11647. And portions of it to the Public Analyst?—Yes.

11648. Is it sent to the Medical Officer of Health?—No, the report itself is not sent to the Medical Officer of Health.

11649. He would seem to be a person interested as usually directing the collection of samples?—Yes, but it would be almost impracticable to supply every officer concerned. The report is sent to the local authority, and it is available to the Medical Officer of Health, if he chooses to ask for it; but a copy is not sent to him personally from the Board.

11650. (*Sir William Hart Dyke.*) You mentioned that it was the practice of the Board now and again to schedule articles. Under what Act does that process take place?—My suggestion was that it might be done if a Court of Reference were established. Then if it were found, we will say, that arsenic is conveyed into certain classes of food by means of glucose, a schedule might be made of the articles on which the Court of Reference had adjudicated as likely to contain arsenic, and an order might be made in reference to those by the Local Government Board, or by whatever Government Department the Acts were administered.

Court of Reference and schedules of deleterious articles of food.

11651. That in itself would be a safeguard for the future; at all events, apart from any administrative action, it would be a very strong warning indeed that such and such a thing had been barred?—Yes. Might I put it in this way: Boric acid is largely used as a preservative. If there were a Court of Reference, that Court may say x grains of boric acid could be safely used in a gallon, we will say, of milk. My suggestion is that it might be made possible for a Government Department—say, the Board of Agriculture—to issue an order under which any excess of boric acid in a gallon of milk beyond x amount would be an offence.

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Actions which might be taken on such schedules.

11652. If Parliament were asked, do you think it would be likely they would consent to such a thing as this—to extend the action of the Sale of Food and Drugs Act farther, and empower the officers of local authorities to enter factories where the articles scheduled in the way you now denote, were being made? For instance, take glucose. Would it be possible by Act of Parliament to extend the action of the Sale of Food and Drugs Act merely to articles which were thus proved to be dangerous. For instance, I will put this case to you. Supposing it were the outcome of this Commission that in all places where glucose was manufactured there should be a right of entry at all times as a safeguard—not a universal power to enter all factories or manufactories or breweries, but wherever glucose was manufactured there should be a right of entry at all times for the protection of the public. What do you say to that?—It would be practicable. I think an analogous case would be the right of entry which is given to the inspectors of the Local Government Board under the Alkali Acts in reference to certain scheduled processes. The processes are scheduled, and the inspectors at all reasonable times are entitled to go into the works and see the processes that are being carried on. The object under the Alkali Acts is to prevent nuisance arising from the process.

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11653. Do you not think it might be possible to legislate in that restricted sense only, whereas if you were to legislate in the general sense, and give right of entry in every possible case for every possible manufactory, there might be very great difficulties and great opposition?—I think a proposal limited in that way would be more likely to succeed in Parliament.

Professor Thorpe.

Professor THORPE, called; and Examined.

Professor Thorpe.

Report of Departmental Committee of Board of Inland Revenue on Arsenic in Beer Ingredients, &c.

(*Professor Thorpe.*) I shall be glad to answer any question you may wish to put to me respecting the report of the Inland Revenue Committee on Arsenic in Beer Ingredients. (Appendix 21), page 208, below.

11654. (*Chairman.*) We have had advance copies of that report. We understand that it is not yet formally presented to us, but that it is to be presented by Sir Henry Primrose, the Chairman of the Board of Inland Revenue, at the next meeting?—Yes.

Methods of testing recommended;

11655. The report relates, does it not, to methods of testing, and describes the system which has been worked out at the Government Laboratory, and which has been found satisfactory by the Committee?—Yes.

electrolytic method and its advantages;

11656. The electrolytic method is described in detail, is it not, and is preferred for reasons stated at page 12 of the report?—Yes.

11657. In particular, it gives more uniform deposits, and it does not necessitate the preliminary destruction of organic matter; that, no doubt, has been checked by a series of experiments?—Yes.

11658. You find there is strong evidence, I believe, that that statement is correct—that it does not necessitate the preliminary destruction of organic matter?—Not as regards some of the things—as regards beer and wort, for example.

11659. Have experiments been made in your laboratory to prove that statement?—Yes; and also in the laboratories of the other gentlemen who have signed the report.

zinc and acid method.

11660. I believe the alternative method, with zinc and acid, is also described in detail in the report?—Yes.

11661. With a few modifications, does it accord with the Marsh Berzelius test?—It is the Marsh Berzelius test.

11662. With the Marsh Berzelius test formulated by the Conjoint Committee of Societies of Public Analysts and of Chemical Industry, as to which we have had evidence?—It was adopted by them, yes. Of course, it is a very old method.

11663. They did not adopt the electrolytic method?—They knew nothing about the electrolytic method.

11664. I believe the advantages and the drawbacks of the zinc and acid method are stated on page 17 of the report?—Yes.

11665. Have you anything to add to that?—No, I think that practically summarises all our knowledge.

Purity and sensitiveness of zinc.

11666. What is the ordinary range of experimental error in the case of the zinc and acid method—for instance, would it always distinguish with certainty a difference of ·002 milligramme?—The zinc and acid method is, of the two methods, the most uncertain in its action. The electrolytic method is practically uniform in its action, and, of course, obviates the use of zinc. Zinc, in the first instance, is a metal which it is very difficult to obtain pure. All commercial samples of zinc contain greater or less quantities of arsenic and of certain other metals, notably iron, which has the extraordinary property of inhibiting the formation of arseniuretted hydrogen. A small quantity of iron mixed with the zinc or present with the zinc will prevent the formation of arseniuretted hydrogen when small quantities of arsenious oxide are actually added to it, so that no sample of zinc can be taken into use by an operator unless he has first assured himself that it contains no arsenic, and, next, until he has assured himself that when arsenic is added to that zinc it will actually form arseniuretted hydrogen. Those conditions are not always possible to secure, and a great number of samples of zinc have, as a matter of practice, to be tested before one is found that will satisfy those conditions. That is one fundamental difficulty connected with the use of the zinc and acid method when you have to detect very small quantities of arsenic—I mean arsenic of the order of 1-100th of a grain of arsenious oxide to the gallon of beer. The amount which we suggest to be used in the case of beer is 25 cubic centimetres of the beer.

11667. Do you find the Marsh-Berzelius test, which was at all events considered to be the best test until this inquiry was made, decidedly uncertain for estimating such small quantities as 1-100th of a grain per gallon?—I should not, perhaps, put it quite so strongly as that. Of course, when an operator has satisfied himself that his zinc is both pure and sensitive, as we call it, then the method is pretty certain in its indications.

11668. But you would not consider it safe that anyone should use it without having satisfied himself by special experiment that his zinc is correct?—That is absolutely a *sine qua non*—that is the first step he must take.

11669. If an analyst was giving evidence as to results, you would ask him: "What steps did you take to make sure that the zinc was correct?"—Yes, he would have to show that he had made special experiments to that effect.

11670. Has it been usual that analysts have taken what they purchase as chemically pure zinc, without themselves ascertaining that it was correct?—No, I do not think so. I think they have all, by a preliminary test, ascertained that the zinc could be used, but it is comparatively recently that it has been discovered that small quantities of foreign metals will inhibit the formation of arseniuretted hydrogen.

11671. But until a year or two ago a careful analytical chemist would have been entitled to consider that pure zinc was safe and sufficient for this test, would he not?—Do you mean what was called pure zinc by the seller of the thing?

11672. That which would be admitted into an accurate scientific laboratory as pure zinc?—No. Of course, the Marsh method has long been employed in toxicological investigations, and it has been absolutely necessary for the toxicological chemist, before he made use of the zinc, for the purpose of detecting the presence of arsenic, we will say, in the contents of a stomach, or whatever it may be, to assure himself that the zinc he has been using is proper to be taken into use; but I am afraid he has not been aware of the fact that although the zinc may show no evidence of arsenic, that is to say, he may not be able to get any arsenical mirror from it, he has not been alive to the fact that there may be associated with the zinc certain metals which would actually prevent the formation of arseniuretted hydrogen. That is a fact which has practically come out in this inquiry.

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11673. The zinc which had been actually used and applied by the analysts in making analytical tests might be deceptive in not giving a mirror when there was arsenic?—Certainly.

11674. And that was not known two years ago?—It was not known.

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11675. Is the Committee satisfied that the tests, as described, can be satisfactorily arranged to any required degree of delicacy by varying the quantity of substance examined?—We prescribe an invariable and uniform quantity of substance to be examined—a uniform amount.

11676. Do you not recommend different quantities of the substance to make sure that they discriminate different quantities?—No, we employ of every particular ingredient which is to be examined a prescribed amount. For example, we say of each particular ingredient how much shall be taken.

11677. In the table given in the report, an illustration is given showing a delicacy of 1-720th of a grain per lb., using 10 grammes of malt, and a delicacy of 1-360th grain per lb., using five grammes of glucose; is that so?—I may illustrate that by these standards, which have been prepared in accordance with prescribed tests. (*The standards were produced.*) Here, for example, are the series of standards which have been prepared in accordance with the electrolytic method for wort, where we take 25 cubic centimetres of the wort, and add to that known quantities of arsenious oxide, and these are the mirrors which are obtained corresponding to the known quantities of arsenious oxide which have been added.

11678. I notice there are some for 1-180th grain per gallon, and some for 1-90th grain per gallon; the mirror in the case of 1-180th looks rather more distributed than in the case of the 1-90th?—It is possible there may be in that particular instance. In these cases we are getting to the disappearing limit of accuracy of the method (*indicated*). It is not sensitive on account of the amount taken; it will not pick up any arsenic less than that in those materials.

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11679-80. When the method begins to fail by losing sensitiveness with 25 cubic centimetres, if you take 50 cubic centimetres would the method then show the quantity more definitely?—Certainly; you have doubled the arsenic present.

11681. When you come almost to the limit of perceptibility would you recommend a larger quantity of the liquor or substance to be taken?—If there is any object in so doing. Of course, you must bear in mind that these tests have been devised with a view to the eventual prescription of warranties and guarantees on the part of the sellers of these articles.

11682. This in every case is metallic arsenic?—Yes. You will see that the amounts obtained by the zinc and acid method are substantially of the same intensity as those which are obtained by the electrolytic method, but on the whole they do not tend to be quite so uniform in their density. Personally I prefer the electrolytic method, and it is the one which we constantly make use of in the Government Laboratory now, because of course, we have a supply of current readily available. But we have worked out the zinc and acid method, because that is a method which probably will be more generally available to the brewer who may not always be able to obtain a supply of current.

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11683. As electric lighting is coming so much more into use, do not you think both brewers and public analysts will feel less and less difficulty in applying the electrolytic method?—I should imagine so. Certainly for judicial proceedings I should much prefer that the electrolytic method was the one used. The reasons for saying that are given in the report, because there is much less of the personal equation in the electrolytic method than in the other one. The thing is automatic, it works itself, and the results of two analysts are very much more directly comparable; there is less discrepancy possible.

11684. As a rule, is it possible, if you are given one of these tubes, to say, after comparing it with other tubes, whether it is 1-72nd of 1-52nd, or something like that?—That is our practice. They are all made according to the prescribed manner, and when the assistant gets a deposit he simply finds which particular mirror it most nearly corresponds with.

11685. Are these tubes given out to people to use, or are these simply specimens?—These are what we ourselves use in the Government Laboratory now.

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11686. You carry the specimens to be examined along from one to another of the standards to see which it agrees with?—Quite so.

Comparison with standard mirrors from specimens originally arsenic-free.

11687. You have a number of different cards containing mirrors in series for the same specified material; if you compare the different cards with one another they agree very nearly?—They do. My own belief is that it does not very much matter which particular card you take, but inasmuch as the method is strictly comparable, we have made standards for every single ingredient of beer; but, as you see, there is no great difference between them.

11688. When the zinc and acid method is used, you take a card in which the mirrors have been formed by the zinc and acid method?—Yes.

11689. For the different substances tested, is your Committee of opinion that the safest plan is to make standard mirrors for each substance?—I think so.

11690. One standard mirror when the substance tested is glucose, and another standard mirror when the substance tested is invert sugar?—Yes, or malt, or hops.

Fuel method.

11691. With regard to fuel, what method has been employed?—The methods of fuel analysis have had to be very carefully worked out in the laboratory. We found that on the whole the most convenient method for determining the amount of arsenic in fuel is by an arrangement which is figured at the end of the report, which in principle is very simple. It consists in taking the powdered coal, or coke, placing it in a hard glass tube, such as I have here (*produced*). We take about 10 grammes of the fuel, and distribute it by a very simple method along the tube. Then we gently warm it, and burn it in a current of oxygen gas. The fuel takes fire, and goes on burning itself; it is only necessary to apply a little extraneous heat after you have once started the combustion. Provided the current of oxygen is sufficiently regulated, no organic volatile matter escapes combustion; eventually the whole of the coke is burned away, and the ash is left deposited in the tube. A certain small proportion of the arsenic, usually about in the proportion of 3 to 7—it varies with the character of the fuel and the nature of the ash—volatilises, is swept forward, and is caught in the little collecting arrangement which contains a very dilute solution of hydrochloric acid or sulphuric acid. If we are using the Marsh test to discover the amount of arsenic we use hydrochloric acid. If we are going to submit it to electrolysis we use dilute sulphuric acid. Then we determine the amount of arsenic which is left in the ash by the method which is described in detail in the report, and the volatilised arsenic is also determined by the direct addition to the Marsh apparatus, or by submitting the solution to electrolysis.

Volatilisation of arsenic.

11692. In what form is it volatilised?—Arsenious oxide.

11693. At what temperature does arsenious oxide volatilise?—At a relatively low temperature; it is one of those curious things which, under the ordinary tension of the air, volatilises without previous fusion.

11694. Like camphor?—Yes. You can chase arsenious oxide from one side of a bottle to another; it is easily volatilised at a comparatively low temperature. One advantage we claim for this method is that it gives the seller and the user of fuel some idea as to the eventual distribution of arsenic in the fuel. I am about to publish a considerable number of determinations which have been made in the laboratory upon fuels which have been actually collected from maltsters, and various specimens of oven coke and gas coke which have hitherto been used. As far as the inquiry has gone, it shows, as I have stated generally, that not more than 30 or 35 per cent. of the arsenic present is volatilised.

Determination of volatile arsenic by fuel test.

11695. 70 per cent. remains in the ash?—Yes.

its relation to volatilisation on the kiln fire.

11696. Is there any evidence that the proportion of arsenic volatilised in this way would correspond to the proportion volatilised under conditions of slow burning in the open fire of a kiln?—As a question of volatilisation, I think yes, but as a case of mechanical distribution of dust by the action of strong currents of air which are going through the kiln, it is not. You will

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have the dust mechanically swept forward and deposited upon the damp grain.

11697. Some of the ash is swept out of the tube?—No ash will go out. I understood you to ask me if it corresponded to what would obtain in practice in kilning, and I say not quite.

11698. In the kiln there is more of the ash carried off?—Yes.

11699. Is there any evidence that the proportion of arsenic actually volatilised in this experimental method would correspond to the proportion volatilised under conditions of slow burning in the open fire of a kiln?—I should think it would; I do not see why it should not; there is no *a priori* reason why it should not.

11700. Would the burning in a current of oxygen be at a higher temperature?—No, not necessarily. Of course, the heat given out is not more than the chemical combination would effect.

11701. Can you say whether there is any approximately fixed proportion between the volatile and the fixed arsenic determined by the test?—No, it varies very considerably. I have not the numbers here, but in some experiments that were made the amount of volatilised arsenic is as little as 10 per cent. of the total quantity of the arsenic which has been there, and in other cases it has been as high as 30 or 35 per cent. That entirely depends upon the nature of the ash. If the ash is highly ferruginous the proportion retained is very considerably greater.

Experimental work in connection with the report.

11702. Have you any further information or experiments to describe besides those we find in the report?—No, I have nothing to say beyond what is there. The report contains none of the experimental facts upon which the conclusions are drawn. We have tested this method, for example, by adding known quantities of arsenical pyrites to fuel. We have mixed very small and gradually-increasing quantities of arsenical pyrites, and we have assured ourselves that we actually do capture the arsenic which we have added to the coal in the form of arsenical iron pyrites. All facts of that kind are not given in the report, which is a mere summary of the conclusions at which we have arrived. Nor does the report indicate the large amount of experimental work which has been done. It has involved in the aggregate thousands of determinations.

Fuel test.

11703. The tests for fuel must include an examination of the ash as well as of the volatilised part?—I think it ought to, in order that the complete history of the thing should be known.

11704. There is no such approximate proportion between the volatilised and the non-volatised part as to allow you to extract sufficient information merely from examining one or the other?—I think not.

11705. How is the ash tested? Is it dissolved in sulphuric acid?—That is described in detail here. It consists practically in dissolving the ash in strong hydrochloric acid, to which there is added a small quantity of bromine. Oxide of iron which has been strongly heated dissolves with very great slowness in the mineral acids, but its solution is very greatly accelerated if there is free chlorine, or bromine, or iodine, or any free halogen. In fact, as a matter of practice, the only way in which the iron does dissolve is by the formation of the free halogen from the acid, and so, to accelerate the solution, we add a small quantity of bromine to it, and in that way, in the course of a very short time, we get the ash into solution.

Action of light on arsenic mirrors.

11706. (*Sir William Church.*) Is it not the case that the colour of these standard mirrors fades by the action of light?—That is said to be so, but I have no absolute experience about it. Of course, as a matter of practice, we keep them in the dark.

11707. At all events, they do not fade sufficiently rapidly for it to be a source of error?—I do not think so to any considerable extent. The greater number of these standards I have brought with me were made 15 or 18 months ago, but some of them have been made within the last six weeks, and I am unable to perceive any substantial difference between those made a few weeks ago and those made 15 or 18 months ago. It is true they are kept in this little case in the dark.

11708. (*Chairman.*) Have you any tubes that have been kept for years?—Yes.

11709. And they do not seem to show any signs of fading?—No, but they have been kept mainly in the dark. There are here a great many tubes which have been obtained in the course of our ordinary routine work.

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11710. (*Sir William Church.*) I only wanted to know whether there was any likelihood of it being a source of error to any amount?—I do not think so.

11711. (*Chairman.*) Some of these tubes have not the same metallic appearance as the other mirrors; some of them are very black?—When they get very dense they get black. They are all brown when we get amounts such as we have here, but with an intense deposit they get very thick and metallic-looking.

11712. When it is very thick and black is it still metallic arsenic?—Yes, it is arsenium.

Fuel test.

11713. (*Dr. Whitelegge.*) In that combustion tube a large proportion of the arsenic remains, and about 30 per cent. goes forward?—It may do.

11714. That which goes forward is arsenious oxide, is it not?—Yes.

11715. Is any of that which remains behind arsenious oxide not in combination?—No.

11716. It remains behind because it is in combination with something else?—Mainly with iron and the like.

Non-volatile arsenic.

11717. Which would make it difficult of solubility in any ordinary media?—It would not be soluble in the water which was used for mashing the malt.

11718. So that if it were, in practice, by a very violent draught, to be carried forward and got mixed with the malt, it would still be different in kind from that which was being carried forward in the experimental tube?—Certainly.

11719. And would not be soluble under conditions of brewing. You regard that as not being harmful in any practical sense?—It is not harmful.

Report does not recommend what standards should be fixed.

11720. I notice in this report the Committee do not attempt any statement of what the standards should be for administrative purposes?—No.

11721. They only describe the tests by which the actual amount can be judged?—That is so.

11722. The chairman touched on that point in the questions he put. In the table in the report different quantities are specified to be taken for analysis, are they not?—Different quantities of the several ingredients.

Quantities of different materials prescribed for testing.

11723. For instance, one gramme of chemicals, five grammes of hops, caramel, yeast, or other substances, 10 grammes of malt fuel or sulphur, and 25 cubic centimetres of wort, beer, or other liquid?—Yes.

11724. What was the underlying idea in taking those different quantities. Was it for the convenience of analysis or was it in the proportion in which those are likely to be present in beer?—I may explain shortly what was the guiding principle which we adopted. We had evidence as the result of a large number of analyses which we made on beers which were obtained from various parts of the country that it was possible by attention on the part of the brewer to secure purity. It was possible for him to obtain beers which contained arsenic in no greater amount than 1-100th grain per gallon. We had many examples of such beers.

11725. In the finished beer?—Yes. Therefore we came to the conclusion there was no reason why beer should contain more than 1-100th grain of arsenic, and we devised a test, and so arranged the conditions of the experiment that quantities larger than 1-100th grain should be perceptible.

11726. In the beer?—Yes, in the beer and in the wort, because practically, short of the amount which the yeast withdraws from the wort, you may say that all the arsenic which is in the wort will go into the finished beer. As a matter of fact, worts as a rule probably contain slightly more arsenic than the finished beer, because we have learned that the yeast to some extent secretes it, and also the hops, which are frequently sulphured. When those sulphured hops are boiled with the arsenicated wort the sulphur combines with a certain amount of the arsenic, and no doubt a small quantity is withdrawn in that manner. We came to the conclusion that that was the ideal, so to say, to which we might strive to attain, the ideal being really secured for us by the efforts of brewers who had done their best by arranging their plant and taking the very best advice they could, and improving their scrubbing machinery as regards malt, and paying attention to the cleanliness of their vats, and doing what they could to prevent the possibility of arsenic occurring. I am referring to the action of the large brewers whom we knew had taken these

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steps, and with whom we were in touch in the course of this inquiry. That practically was what was fairly attainable by brewers with the best appliances, and working under the best conditions, and paying due attention to those conditions. Therefore, so to speak, that was the working basis upon which we started—we arranged the tests as regards their stringency so that they should capture any arsenic which was higher than 1-100th grain per gallon of wort or of beer.

11727. Assuming that the whole of the arsenic going into that wort or beer came from the particular ingredient in question?—I was going on to say that when we had, so to speak, fixed our ideal standard with reference to beer, we then had regard to the amounts of the particular ingredients which would be used to make that beer, and we then took such an amount of the several ingredients—the malt, glucose, invert sugar, and the other ingredients—that by no possibility, supposing they passed our test, could an amount as great as 1-100th of a grain per gallon be in the beer.

11728. If you are examining the glucose you think of a standard for glucose such that if no arsenic is added except through glucose the limit would be 1-100th?—As regards glucose, the amount of glucose which we recommended to be tested, and on which we based our tests, was so large that the beer might be considered as wholly derived from glucose. That is the amount we prescribed. If a sample of glucose passes our test the amount of arsenic either in the wort or in the finished beer is certainly less than 1-100th grain per gallon.

11729. I am afraid I do not quite follow that. What proportion is the glucose to the beer? Can you give me a comparative figure?—Do you mean what is actually in use now.

11730. Yes?—Perhaps 25 or up to 30 per cent.

11731. Then if you are aiming at excluding anything worse than 1-100th grain of arsenic from beer, how would you work that out in terms of the glucose? Would you say that the glucose being 25 or 30 per cent., you must allow a proportionately severe test for arsenic in it?—We have enormously increased the severity of the test as applied to glucose, because we prescribe that such an amount of glucose should be employed for the test as would be present in 25 cubic centimetres of beer or wort, assuming that nothing else but glucose had been used to make that wort or beer. We have enormously increased the stringency as regards the test on glucose.

11732. Naturally; the test on the glucose would have to be more stringent than the test on the beer. But supposing, for example, that each of the ingredients of a beer came up to the limit of arsenic which you have in your mind for those ingredients, would that yield a beer containing more than 1-100th grain per gallon?—No. By the application of the tests to the individual ingredients of beer, assuming that those individual ingredients passed these tests, by no possibility could you have as much as 1-100th grain in the finished beer.

11733. Even if they all contributed as much as your tests allow?—Yes.

11734. Then you have taken as your basis a calculation of that kind, and you have not attempted to bring down the exclusion of arsenic to the furthest possible point? You had regard to the arsenic in the finished product?—Yes, we first of all had regard to the arsenic in the finished product, and then we tried to get rid of the further quantity of arsenic by increasing the stringency of the test on the individual ingredients.

11735. Does it not follow from that that you would not think it necessary to say that an individual ingredient must be as free from arsenic as practicable if it is only a small ingredient? If you have regard to the proportion in which it would be present in the beer, it must follow that you are less severe upon the ingredients which are used in smaller proportion?—No, that is not so. As a matter of fact, we have no regard to the proportions in which some particular things may be present. For example, if you turn to the chemicals, there are certain alkaline solutions which are used to revivify or what is called regenerate the beer. They are used in very small quantities, but we have been as stringent with them as regards their purity as would be the case of a substance which is used to a large extent in beer. We have not apportioned the degree of stringency to the relative proportions of the quantity used. We thoroughly discussed that. If it is practicable for a man to secure practical freedom from arsenic in such a material as carbonate of potash, it is no answer to us that because he used such a material in only a very small quantity the obligation to furnish that thing free from arsenic should be less stringent than in the case of the maltster.

Official limit should be governed by purity attainable rather than by quantity used in beer.

11736. Then, substantially, these different quantities are taken for the convenience of chemical analysis, are they not?—Partly that; but, of course, with some regard, especially in the case of glucose and other things, to the amounts in which they may enter into the composition of the beer.

11737. That does come in?—To a certain extent, of course.

(Professor Thorpe here exhibited and described to the other members of the Commission the various apparatus and mirrors above referred to.)

Dr. Thomas M. Legge, Medical Inspector of Factories, Home Office, called; and Examined.

Dr. Thomas M. Legge.

11738. (*Chairman.*) You have handed in a statement with regard to the symptoms met with in industrial poisoning by arsenic; may we take that as your evidence on the subject?—Yes.

(Statement appears below at end of witness's evidence.)

11739. Have you inquired into several cases of arsenical poisoning arising in the course of employment?—Yes, a certain number; but the number reported is not large.

11740. Is the Home Office informed of all such cases?—No; I could not say it is informed of all. Medical practitioners are required by Section 73 of the Factory and Workshops Act, 1901, to report cases occurring in their practice if contracted in factories and workshops to the Chief Inspector of Factories, but I cannot say that the requirements of the section are known to every medical practitioner throughout the country. But wherever arsenical poisoning is common—where, for instance, there is a factory in which arsenical preparations are made—it would be known.

11741. You consider the cases reported to the Home Office are fair samples of the whole?—Yes, I do.

11742. Will not the cases which are reported be rather extreme cases? Will they not probably be worse than many cases which are not reported?—That is so, but the medical practitioner must be the judge of what arsenical poisoning is, and what stage it reaches before he notifies it.

11743. There must be many cases in which there is evidence of arsenical poisoning, but only to a slight degree?—Yes, evidence of the effects of arsenic, which might not amount to arsenical poisoning.

11744. By poisoning, do you mean death by poisoning?—No; symptoms of such severity as to keep them away from work. They may have slight symptoms of the effects of arsenic without being absent from work at all: in fact, the majority of them would have that, I should say.

11745. And those would not be reported?—No.

11746. You have seen cases that have not been reported, and seen their progress?—Yes.

11747. Poisoning by arseniuretted hydrogen is rare, is it not?—Yes.

Arseniuretted hydrogen poisoning.

11748. But it has occurred, has it not, in certain instances where hydrogen was being evolved during a manufacturing process in which hydrochloric acid was used that was highly arsenical?—Yes. In a manufactory of bleaching powder there were three cases, with two deaths; in a chemical works for making zinc chloride there were 13 cases, with one death; and in a galvanising iron works there were seven cases, without a fatal result.

11749. Were those all due to arseniuretted hydrogen?—They were believed to be due to arseniuretted hydrogen. The symptoms in the galvanising iron factory were much slighter than in the others, and the evidence was not so strong there, although the symptoms pointed more to arseniuretted hydrogen than to anything else.

11750. But there was no death in that instance?—

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That is so; it involved absence from work in most of the cases for about three weeks. The cases were severe to that extent.

its symptoms.

11751. Broadly speaking, what are the symptoms of such poisoning?—The typical symptom is coppery jaundice, which develops in the course of from 24 to 48 hours, and hæmoglobinuria.

11752. Poisoning of that kind has almost nothing in common with the symptoms of chronic poisoning due to arsenic in beer?—There is practically no resemblance at all. Arseniuretted hydrogen poisoning acts powerfully in destroying the red blood cells.

Poisoning from exposure to arsenical dust.

11753. Poisoning among workers exposed to arsenical dust arises occasionally, does it not, in factories of emerald green and sheep dips, and also among men in Cornwall who roast arsenical ore to obtain arsenic?—Yes; the symptoms in all those cases are very much alike—irritation of the skin and mucous membranes, without, as a rule, symptoms of paralysis or neuritis They are local symptoms.

Symptoms are of local irritation; neuritis rare.

11754. The symptoms are not felt acutely, and there is not much pain?—No; it causes very considerable discomfort, but it does not undermine the health in the same way, for instance, that persons exposed to salts of lead suffer.

11755. When the sufferer gets over the attack is he the worse for it, or does he get quite well again?—He gets quite well.

11756. There is nothing cumulative in the system?—Nothing, as far as we can judge, except that they do get pigmentation of the skin undoubtedly. This is the notification received of a case from an emerald green works only three weeks ago. (*Document handed in.*)

11757. What is emerald green?—Aceto-arsenite of copper.

11758. It is not the same as Scheele's green?—I think it is. The paper I have handed in is quite typical of the cases notified from these emerald green works, but it is more severe than many of them.

11759. How does the poison obtain access to the workmen—from dust?—Yes, from very fine dust indeed.

11760. From inhaling dust?—From the dust alighting on the skin, and also from such dust as gets on the fingers being rubbed on the face and other parts.

11761. Is an abrasion injurious?—I should say that it is. I think the dust generally lodges in a crack, and there acts as an escharotic. The eczema is most prominent round the corners of the nose, the ears, the eyes, and the mouth.

Arsenic in dust probably insoluble.

11762. Can you suggest any reason for the difference that is presented between this poisoning and the poisoning from arsenicated beer?—Except that in beer the arsenic would be in solution.

11763. The substances that you speak of in the dust are not commonly called soluble?—I should say not.

11764. Is emerald green soluble?—I do not quite know what the solubility of it is. It dissolves entirely in an excess of alkali and in acids.

11765. But not in pure water?—I should say not.

11766. Can you say, approximately, how many works there are where emerald or Paris green and sheep-dips are made?—There are about three factories in which emerald green is made on any scale, and perhaps 10 in which sheep-dip is made.

11767. What is emerald green used for chiefly?—As an insecticide.

11768. Not for a pigment?—To some extent, but far more largely as an insecticide. I do not think it is used in the manufacture of wall paper now.

Arsenic in green tapers.

11769. These two wax tapers (*produced*) are said to contain 5·32 per cent. of arsenious acid, of white arsenic. Do you think these are made with emerald green?—I should think it is quite likely.

11770. Is emerald green used in ordinary green wax tapers?—I was not aware that it was.

11771. There is a prodigious proportion of arsenic in these wax tapers?—Yes.

11772. These tapers have been sent by an excellent chemist (Mr. William Thomson, of the Royal Institution Laboratory, Manchester), who says that the quantity of arsenic tri-oxide in each has been tested, and that he has found it to amount to 5·32 per cent. of the whole weight of the tapers?—It is used to some extent as a pigment still.

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11773. These tapers would be very dangerous things on a Christmas tree, or anything of that kind; a great deal would get into the air if they were burned?—Yes.

11774. Is there any evidence that heavy drinkers are more affected than other workers by industrial arsenical poisoning?—None whatever, I should say; I have no evidence on that point.

11775. I notice you state "Emerald or Paris green." Is that the same thing?—I believe it is exactly the same thing.

Use of emerald green.

11776. You do not know what substances are now coloured with emerald green?—No, beyond that it is used as a pigment. I have seen it used in railway wagon works for painting crests, and I have seen it used at Woolwich Arsenal in painting.

11777. And in paint shops is emerald green used as a pigment?—They make a little of it.

11778. Does sheep-dip contain arsenious acid?—Yes, arsenic sulphide and free arsenious acid.

11779. Can you say whether the workmen suffer more in making sheep-dip or in making emerald green?—Much greater in emerald green, I should say. In the manufacture of sheep-dip a peculiar condition of erosion of the septum of the nose is brought about.

Perforation of nasal septum.

11780. I see you say that the men do not know that they have had perforation?—All do not know. The perforation is similar to that found very commonly among men working in factories where bi-chromate of potash is packed.

11781. Does bi-chromate of potash act as a poison similar to arsenic?—It does, very largely, in the same way, creating sores on the skin, especially where the bi-chromate gets into cracks or folds in the skin.

11782. Those perforations will cause permanent destruction of that part?—Quite, but it is limited. It does not involve the whole of the septum of the nose, so that there is not much disfiguration in the cases where it has occurred.

11783. Have you personally examined into the state of health of men employed in roasting arsenical ore to recover arsenic?—Superficially only.

11784. Has this ever been made the subject of expert medical inquiry?—Not of expert medical inquiry, but the conditions of work have been carefully gone into in a report by Mr. Gould, the late Deputy Chief Inspector of factories, and Mr. Martin, one of the Inspectors of Mines.

11785. Where are the arsenic mines chiefly?—In Cornwall.

11786. Is it got from pitch-blende?—I think the ore there is called mundic.

Reported cases of industrial arsenical poisoning very few.

11787. (*Sir William Hart Dyke.*) This small schedule that you have given us in your précis of cases covers the three years, 1900, 1901, and 1902; have you extracted that from the Home Office report?—Yes; they are summarised every year by myself in my annual report to the Chief Inspector.

11788. What is the scope of this schedule?—It represents the cases which have been reported under Section 73 of the Factory and Workshop Act.

11789. Throughout England and Wales?—Throughout the whole of the United Kingdom.

11790. These are the total cases that have come under your cognisance?—Yes.

11791. I see that in 1900 there were 14 cases in chemical works and three deaths, but that in the two succeeding years there was not a single case nor a single death. Can you explain that?—The whole of these cases occurred in two chemical works, and they were all due to the same cause—the evolution of arseniuretted hydrogen in the vat affecting a group of men all working together.

Arseniuretted hydrogen poisoning.

11792. Was that due to any carelessness on the part of those conducting the works, or was it the result of a new process?—In the factory where there were ten cases, they were pouring rather impure hydrochloric acid on to zinc in a large open vat in the open air, in order that the fumes might get away completely, but in order to protect the men against rain and bad weather they had put a little lean-to roof close by for them to take shelter under, and on the particular

day in question—it was a sultry day—the lean-to roof seems to have caught the fumes and kept them there, and the men who were working anywhere near that shelter suffered.

11793. It was an accidental circumstance, then, owing to this lean-to roof being put up?—Very largely. It would have been possible for the firm before that to have made arrangements for carrying away the fumes into a tall chimney.

11794. Do you consider that the present machinery of inspection at the Home Office is sufficient to safeguard these workers in factories and elsewhere?—I should say so.

11795. There is no evidence before your mind at this moment that would lead you to advocate any amendment of the law, and any further protection than that now afforded?—No, I should say not.

11796. (*Sir William Church.*) Can you tell me whether emerald green and Paris green are the same? I thought they were distinct?—I believe they are the same, but I could not be positive on the point.

11797. What number of men do you think are employed in the colour industry where arsenical pigments are made?—I should not think there are more than two to three hundred.

11798. In London?—In the whole of England. There are not more than two or three hundred coming into contact with these arsenical colours. In this particular factory, where most of the cases have occurred, the work is so arranged that the men do not come into contact with the emerald green more frequently than for one day once or twice a week.

11799. (*Chairman.*) Where are those factories?—This particular factory is in the north of London.

11800. Is emerald green sold as a finished product, as a powder?—Yes, to be mixed with oil for paint, or, I suppose, to be mixed with water and sprayed on to the roots of trees.

11801. (*Sir William Church.*) Assuming that it is the same as Paris green, it is really made for an insecticide?—Yes, I believe great quantities of it are exported to America for destroying the Colorado beetle.

11802. There is a great deal used in England, too, in fruit gardens, for dressing apple and other fruit trees?—Yes, that is so.

11803. I see that very few of these workers suffer from the ordinary effects of arsenic, such as diarrhœa?—Very few.

11804. Or abdominal pain?—I think that is probably to be accounted for by the alternation of work—that it is considered so unpleasant in its effects that they do not work at it for many days together.

11805. What are they working at in the interval?—They are packing other powders and paints.

11806. Lead paints?—Sometimes.

11807. Have you personal experience of the arsenic workers in Cornwall?—I have visited there once.

11808. With regard to these eczematous eruptions that occur in paint workers, are they similar to the ones in Cornwall, are they of the acute form?—Just the same. The only thing is that in Cornwall the workers seem to get a larger local ulcer than they do in these paint and colour works, but I do not suppose the powder is so fine.

11809. I see that in the list you have given only one amongst 25 is stated to have had pigmentation, and that person had no other symptom whatever?—Yes.

11810. How do you know what the character of it was?—I remember distinctly that it was round the eyes very markedly in that particular case. It was the case of a woman who had been a forewoman at the works for several years.

11811. But pigmentation round the eye in a woman is a very common thing?—Yes, coupled with anæmia.

11812. With or without anæmia, but especially with anæmia. Pigmentation from poisoning through beer is so very marked and quite different from the pigmentation that you get in other cases?—I was examining these people more with a view to seeing the eczematous condition, and I was not paying very much attention to pigmentation then, but it was sufficiently great in her case to specially draw attention to it.

11813. It may not have been arsenical?—It may not.

11814. Apparently none of the others had marked pigmentation. There is nothing said about pigmentation in this report in regard to Cornwall?—No.

11815. Any more than there is of neuritis?—But if you look at the symptoms in these sheep-dip cases you will see that almost everyone had very marked pigmentation, and I think it is quite likely that if one's attention had been more specially directed to the point of pigmentation one would have got evidence. no evidence as to pigmentation or neuritis among them.

11816. One would have expected that in these people who handle it keratosis would happen?—Yes.

11817. That does not seem to be mentioned in either report?—Do you think it would after employment for only six weeks? The duration of employment of these women is put down here, and it is very short. You must remember that the article is only made during the six winter months. It is never made in the summer.

11818. (*Chairman.*) Are these cases chiefly women?—Those you are looking at are all women, but in the report I have handed in to-day they are mostly men.

11819. (*Sir William Church.*) Do you get any cases of arseniuretted hydrogen poisoning?—We have had no cases this year.

11820. I suppose they are all quite exceptional?—Yes. The symptoms are so little known that it is quite likely a case or two occurs which we do not hear of.

11821. (*Chairman.*) Why does the manufacture only take place in the winter months?—Because the demand for it is not sufficiently great to make it necessary to manufacture it all the year round.

11822. (*Dr. Whitelegge.*) You do not think the pigmentation is a local result?—No, not at all.

11823. You take that as a constitutional effect of the arsenic?—Yes.

11824. From what we have heard, the keratosis comes on rather late—it is a late manifestation of peripheral neuritis. You have not seen or heard much of peripheral neuritis in arsenic workers?—No.

11825. You cannot tell us anything about the arsenic affection of workers in mines?—No.

11826. It would be outside your official province? You have not heard of it?—I have heard of the severity of bronchitis amongst the Cornish miners.

11827. All the cases reported under the Factory Act would come to your knowledge?—Yes.

11828. You were saying that some cases would be so slight as not to be brought to light in that way, and that they would not prevent a man going on with his work. But that would not affect the reportability of the cases, would it? It is not like the reportability of an accident, which depends on absence from work?—No, it depends entirely on the view taken by the medical practitioner. Cases reported to Home Office

11829. It depends on whether it impresses the practitioner as being of sufficient importance to be called arsenical poisoning?—Yes.

11830. But arsenical poisoning, however slight, and even if it did not require absence from work, would still be reportable?—Yes, if the medical practitioner believed that it was so.

11831. Without any condition as to the absence from work?—Yes. But at the same time I must say that of the men examined at the sheep-dip works, with one exception, none were reportable cases.

11832. Why?—Because I do not think that they constitute arsenical poisoning. In my opinion they would not be so.

11833. I only want to make it clear that we are not to understand that absence from work is essential for reporting arsenical poisoning?—No.

11834. Do you know anything as to the condition of the hair in these cases? We have had some interesting evidence—I do not know how far it has been published—as to the finding of arsenic in the hair of persons constitutionally affected by it?—I thought of getting some hair, but it seemed to me that it would be difficult, in view of the very fine powdery state of both the sheep-dip and the emerald green, to get it out of the hair.

11835. Still, it would be interesting, as showing the constitutional effect?—Yes.

11836. It is a fact, is it not, that this requirement of notification of arsenical poisoning has been in force since 1895?—Yes.

11837. But that prior to the dates given here—I think the first is 1900—the statistics were not as well organised as they have been later under your charge?—That is so. There was only one case which was known to have occurred before.

11838. You have right of entry to all factories and workshops, have you not?—Yes.

11839. Do you meet with any difficulty—is your right challenged?—No.

11840. Do you have to go to places where you have not any statutory power of entry?—Such, for instance, as warehouses.

11841. They would come under the Act, and you would have power of entry there? Take industries carried on at home?—Yes, I have visited some of those.

11842. Have you found any difficulty in gaining admission there?—No, but I have had to show my authority on one or two occasions.

11843. You have to prove that you are a Government official, and then there is no difficulty?—Yes.

The following is the Statement handed in by Dr. Legge.

SYMPTOMS MET WITH IN INDUSTRIAL POISONING BY ARSENIC.

The Chief Inspector of Factories receives information of cases of arsenical poisoning in accordance with the requirement of section 73 of the Factory and Workshop Act, 1901, which is as follows:—

"Every medical practitioner attending on or called in to visit a patient whom he believes to be suffering from lead, phosphorous, arsenical, or mercurial poisoning, or anthrax, contracted in any factory or workshop, shall (unless the notice required by this sub-section has been previously sent) send to the Chief Inspector of Factories at the Home Office, London, a notice stating the name and full postal address of the patient and the disease from which, in the opinion of the medical practitioner, the patient is suffering, and shall be entitled, in respect of every notice sent in pursuance of this section, to a fee of two shillings and sixpence, to be paid as part of the expenses incurred by the Secretary of State in the execution of this Act.

"Written notice of every case of lead, phosphorous, or arsenical, or mercurial poisoning, or anthrax, occurring in a factory or workshop, shall forthwith be sent to the inspector, and to the certifying surgeon for the district; and the provisions of this Act, with respect to accidents, shall apply to any such case in like manner as to any such accident as is mentioned in those provisions."

The notifications thus received cannot represent all the cases which occur—they are samples distributed over various industries, and are useful in suggesting lines of inquiry, and indicating the direction in which remedial measures are necessary.

The requirement of the section quoted, which dates from the Factory and Workshop Act of 1895, is still not universally known to medical practitioners, as industrial poisoning of the kinds specified is usually an accident in their professional life, and not like scarlet fever, etc., an incident. No absolute definition of arsenical poisoning is possible, and each practitioner in reporting what he believes arsenical poisoning to be must form his own standard.

One case only of arsenical poisoning was reported between the years 1895-1899, viz., in the manufacture of paints and colours in 1895. The number since then has been as follows:—

	1900.				1901.				1902.			
	Cases.		Deaths.		Cases.		Deaths.		Cases.		Deaths.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Paints and Colours	–	6	–	–	3	–	–	–	4	1	–	
Chemical Works	14	–	3	–	–	–	–	–	–	–	–	
Galvanising	–	–	–	–	7	–	–	–	–	–	–	–
Paper Hanger	1	–	–	–	–	–	–	–	–	–	–	
Brass Polisher	–	1	–	–	–	–	–	–	–	–	–	
Flowers	–	–	–	–	–	1	–	–	–	–	–	
Copper Extraction	–	–	–	–	–	–	–	–	1	–		

I have little doubt that the cases reported in a paper-hanger and brass-polisher were not due to their employment, but were probably due to arsenic in beer. No arsenic was found on analysis either in the wall-paper, which the man had been chiefly engaged in hanging, or in the composition used in the brass-polishing. In the latter case, which occurred in Birmingham, in June, 1900, the certifying surgeon definitely stated his opinion that the symptoms were due to alcoholism.

Industrial arsenical poisoning usually occurs in two forms: (1) from the inhalation of arseniuretted hydrogen gas, and (2) from inhalation of, or contact with, the dust of salts of arsenic. In the latter case there is direct manipulation of the salts, while in the former the toxic arsenical agent is present as an impurity in the substances used for one purpose or another, and the workman is, therefore, usually quite ignorant of its presence.

The symptoms from these two sources bear no resemblance to one another. The first exerts a destructive influence upon the red blood corpuscles, the second acts as a local irritant, or escharotic on the skin and mucous membrane. Neither gives rise as a general rule to neuritis or paralysis.

(1).—Arseniuretted Hydrogen Poisoning.

The cases which have come under my notice number 20, with three deaths—13 in 1899 and seven in 1900. The source of the poisoning in each case was believed to be impure hydrochloric acid.

The cases occurred in three works (*a*) in the manufacture of bleaching powder (three cases with two deaths), (*b*) in the manufacture of zinc chloride (13 cases with one death), and (*c*) in galvanising iron (seven cases without fatal issue).

In addition to these which may be said, strictly speaking, to have been contracted in factories and workshops, mention should be made of the following, recorded by Layet*:—

(i.) Nine persons (1876) engaged in a silver mine in pouring hydrochloric acid on to argentiferous zinc to extract the silver were attacked, and three died. Arsenic was found in all the organs analysed.

(ii.) Four Italians, vendors of coloured india-rubber balloons for children, after filling them with hydrogen gas, obtained from commercial sulphuric acid and common granulated zinc, were attacked, and one died. The room in which they carried out the operations is

* L'Hygiene Industrielle. Paris. 1897. pp. 485-487.

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described as having had a cubic capacity of about 700ft., and to have been ventilated only by a broken window-pane.

(iii.) The deaths of two aeronauts from the escape of gas from balloons.

Other sources of arseniuretted hydrogen poisoning, which have been described by Layet, but of which I have no knowledge, are:

(i.) The manufacture of aniline colours by the action of arsenious acid on aniline oil. I believe this process is now discontinued.

(ii.) The manufacture of cobalt.

The train of symptoms resulting from the inhalation of the gas are characteristic:—

In the course of a few hours there is shivering, followed by weakness, headache, vomiting, rapid weak pulse, and collapse. After some eight to ten hours, and later, the destructive action of the gas on the red blood cells shows itself in haemoglobinuria, and in very severe cases anuria. After twenty-four hours jaundice appears, and usually becomes of an intense coppery hue. Death may occur within twenty-four hours, but in the majority of cases is delayed until the lapse of a week or more. Recovery in the mild cases is slow.

I append particulars of the cases which have come under my own notice (see pp. 457-566 of the Annual Report of the Chief Inspector of Factories for the year 1900, and p. 234 of the same for 1901), and of others of which I have been able to find record. Reference is there made to the work of Dr. Dixon Mann and Dr. Gray Clegg* which summarises much of our knowledge on this subject. They describe in detail the pathological changes observed in two fatal cases.

In discussing the nature of the icteric hue of the conjunctiva and skin they conclude that, although the rapid occurrence of this symptom after the appearance of free haemoglobin in the blood plasma gives support to the view that the jaundice is of haematogenous origin, the weight of evidence is in favour of the liver being concerned in the "production of jaundice in all cases, even in those in which, owing to destruction of, or injury sustained by, the red corpuscle, free haemoglobin is present in the general vascular system."

Almost all the cases of arseniuretted hydrogen poisoning contracted in factories or workshops appear to have been due to work which has been carried on in confined spaces, or under conditions in which the means for the removal of the gases evolved were inadequate, and the remedy, therefore, is obvious.

(2).—Poisoning by Salts of Arsenic.

The principal industries giving rise to lesions from this source which have come under my notice are: (1) The extraction of arsenic; (2) the manufacture of Paris or emerald green; and, (3) the manufacture of sheep dip.

Poisoning from the use of Scheele's green in the manufacture of wall-papers or of artificial flowers, is not now believed to occur, as other pigments have been substituted for it. Other industries in which arsenious acid is used, and in which injurious cutaneous effects have been noted (although I have no personal knowledge of them) are—the preservation of hides and skins, the use of caustic potash and arsenious acid as a depilatory in tanneries, and its use in dye works.

(1.) *Extraction of Arsenic:*—Arsenical ore (mundic) is roasted and the arsenic thus volatilised is deposited in flues from which it is collected and again roasted and again deposited in flues. The white arsenic thus obtained is ground in a covered-in machine, and while being ground it is automatically packed in barrels, thus obviating dust.

The symptoms among the workers are eczema, and the development of ulcers where the skin has been broken. I have no doubt that pigmentation would be observed if looked for.

The precautions taken in addition to those mentioned are the provision of overalls, respirators (handkerchiefs), washing accommodation, baths, and protection of abraded surfaces.

The subject of alleged injury to health, as carried on in this industry in Devon and Cornwall, has recently been made the subject of inquiry and report by Mr. Gouldt, late Deputy-Chief Inspector of Factories, and Mr. Martin, Inspector of Mines.

(2.) *The Manufacture of Emerald Green and Paris Green:*—I have seen the manufacture on any scale carried on in one factory only. All the reported cases (four in male workers and seven in females) occurred there. The lesions are marked, but limited to the cutaneous, catarrhal, and gastro-intestinal types. In the extracts from the Annual Report of the Chief Inspector of Factories for the year 1900, I give the symptoms noted among the female workers. The manufacture takes place only in the winter months, and appears to depend largely on the prevalence of the insect pests which these insecticides are used to destroy.

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The conditions of work in this factory were made the subject of Home Office inquiry in 1893, in consequence of publicity given to the alleged injury caused to the workers.

The process of manufacture consists essentially in dissolving sulphate of copper in water. To this is added a solution of arsenite of soda, made by boiling arsenious acid in a solution of soda. Acetic acid is added to this. The precipitate of emerald green so formed is well-washed in water. Thus far the workers run no risk, as there is no exposure to dust. By means of cloth filters the water is removed, and the clay-like mass is dried in a stove. The dried material is emptied into a hopper, in which operation dust is created (now minimised by a fan draught). The colour is next mixed in a revolving enclosed cylinder-sieve, and finally packed in small cases, which are placed under hoods connected with a fan draught. The powder is extremely light and fine, and "flies" readily.

Precautionary measures adopted in processes involving exposure to arsenical dust, in addition to the fans (which are, of course, the chief), are overall suits and head coverings, respirators, washing accommodation, and baths, alternation of employment (no man being allowed to work more than one day in seven). Periodical medical examination once a week has been instituted since 1899.

(3.) *Manufacture of Sheep Dip:*—The manufacture is carried on in about ten factories and workshops, of which I have recently visited four. I append the result of the superficial examination of 18 men employed in the largest of them. Perforation of the septum of the nose had not been mentioned to me in any of the factories visited as one of the effects of the employment. On the condition of No. 12 being noted, I was informed that they were the symptoms which would be presented by nine out of ten persons on commencing work. None of the men examined confessed to injury to health from their employment. Sheep dip is an arsenite of soda containing arsenic sulphate and free arsenious acid. The process of packing gives rise to considerable dust.

Precautionary measures taken are to cover over the grinding mills and sieves. In two factories the finely ground material is conveyed to the packing benches by means of a continuous worm. Overalls, head coverings, and respirators (of cotton wool, and held in place, as shown in the diagram opposite p. 41 in Mr. Gould's Report) are habitually worn by workers exposed to dust. Washing accommodation is provided, and in some factories baths also. Machinery for carrying out grinding and packing automatically is to be installed in the principal factory shortly.

The perforation of the septum of the nose is similar to that which occurs to workers in bichromate factories. A portion only is attacked—the anteric. and inferior margins remain free, and thus rigidity of the parts is maintained and deformity absent. Necrosis of the central portion is accounted for by the fact that the mucous membrane covering it is adherent, forming the perichondrium, and is far less vascular than the mucous membrane lining the rest of the nasal fossae. It is the seat of election for the dust to alight upon, and once the mucous membrane is destroyed, the blood supply to the cartilage is cut off, and necrosis ensues. The morbid process is ushered in by sneezing, and the ordinary symptoms of nasal catarrh. Pain accompanying it appears to be very slight, and it is certain that many of the men were unaware of the perforation.

Ulcers on the hands, as intense as those frequently found among bichromate workers, were not observed. Workers, however, do require to protect abrasions, as there is a tendency for them to ulcerate if dust gets

* Medical Chronicle, Vol. III. (New Series), p. 161. 1895. † Report forwarded to Commission

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to them. Occasionally the scars of such ulcers were noted—more commonly, perhaps, on the hands of those engaged in the extraction of arsenic than in the others.

Slight conjunctivitis is common. The throat is markedly congested, but the symptoms of hoarseness so noticeable in workers in emerald green is much less common in those handling sheep dip.

Pigmentation was most characteristic around the eyes, and on the temples, neck, chest, and in the armpits. It appears to get less pronounced after many years' work. Affections of the nails and hair were not observed.

History of definite gastro-intestinal, or of nervous affections was not forthcoming.

Arsenious acid enters as an ingredient into the composition of enamels—especially of those used in the manufacture of enamelled copper letters. Several analyses of these have been made in the Government Laboratory, which show that lead is present to the extent of about 40 per cent., and arsenic from 5 to 8 per cent. I have examined many workers exposed to the dust, and while evidence of lead absorption is abundant, I have not had my attention drawn to symptoms attributable to the deleterious action of arsenic.

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EXAMINATION OF MEN EMPLOYED IN MANUFACTURE OF SHEEP DIP.

No.	Name.	Age.	Duration of Employment.	Occupation.	Perforation of Septum.	Skin.	Throat.	Eyes.	Gastric.	Neuritis.	—
1	A. G.	29	3 years	Mixing and grinding.	Nil	Nil	Congested	Slight conjunctivitis.	Nil	Nil	
2	W. C.	34	14 years	Mixing and grinding.	Nil	Marked pigmentation, no eczema, veratoris of palms.	Congested	Slight conjunctivitis.	Diarrhœa once for four days.	Nil	
3	H. G.	33	11 years	Wrapping	Nil	Slight pigmentation, no eczema, roughness of palms.	Congested	Slight conjunctivitis.	Nil	Nil	
4	E. G.	37	14 years	Crushing	Nil	Marked pigmentation, mottling of skin, no eczema.	Congested	Nil	Nil	Nil	
5	H. E.	28	4 years	Wrapping	Yes, $\frac{3}{4}$" by $\frac{1}{4}$"	Pigmentation, mottling of skin.	Congested	Slight conjunctivitis.	Nil	Nil	This man returned to the work after services in the Army.
6	T. L.	22	4 years	Mixer	Nil	Marked mottling of skin, with furfuraceous desquamation in places.	Congested	Nil	Nil	Nil	
7	W. N.	35	17 years	Wrapping	Nil	Slight pigmentation, said to have been much more marked previously.	Congested	Loss of eyelashes	Nil	Nil	
8	H. P.	33	20 years	Wrapping	Yes, complete	Slight pigmentation	Congested	Nil	Nil	Nil	
9	W. T.	26	13 years	Wrapping	Yes, complete	Pigmentation	Congested	Nil	Nil	Nil	
10	J. H.	50	40 years	Foreman	Yes, $\frac{1}{2}$" by $\frac{1}{4}$"	Slight pigmentation, said to have been worse previously.	Congested	Nil	Nil	Nil	
11	R.	49	22 years	Wrapping	Nil	Pigmentation	Congested	Slight conjunctivitis.	Occasionally diarrhœa.	Nil	
12	A. C.	19	4½ months two years ago, four months this year.	Mixing	Yes, $\frac{1}{4}$" by $\frac{1}{4}$"	Pustular eruption on chin, arms, and hands, no special pigmentation.	Congested	Slight conjunctivitis.	Nil	Nil	
13	F. W.	35	21 years	Wrapping	Nil	Pigmentation, slight eczema	Congested	Nil	Nil	Nil	
14	C. D.	32	17 years	Wrapping	Nil	Marked pigmentation	Congested	Slight conjunctivitis.	Nil	Nil	
15	H. W.	28	14 years	Wrapping	Nil	Marked pigmentation	Nil	Slight conjunctivitis.	Nil	Nil	
16	M. J.	32	19 years	Wrapping	Yes, complete	Marked pigmentation	Nil	Slight conjunctivitis.	Nil	Nil	
17	S. R.	28	13 years	Wrapping	Nil	Marked pigmentation	Nil	Slight conjunctivitis.	Nil	Nil	
18	B.	? 16	1½ years	Carrying boards	Yes	Marked pigmentation	Not examined	Nil	Nil	Nil	

TWENTY-NINTH DAY.

Friday, 3rd April 1903.

At 1, Chapel Place.

PRESENT:

The Right Hon. Lord Kelvin in the Chair.

The Right Hon. Sir William Hart Dyke.
Sir William Church.
Professor Thorpe.
Dr. Whitelegge.

Dr. Buchanan, *Secretary.*

Sir Henry Primrose, re-called; and Examined.

Sir H. Primrose.

11844. (*Chairman.*) I believe we are to have information from you as to the action taken by the Board of Inland Revenue since the date of your last appearance before the Royal Commission on May 3rd, 1901?—Yes.

Action taken by Board of Inland Revenue since former evidence.

The next stage was the issue of the interim report of the Commission, which was presented in July, 1901. The last paragraph of your interim report, No. 34, was one which specially interested the Board of Inland Revenue. The paragraph says:—

"(34) To this end we recommend that the Board of Inland Revenue should possess and should exercise powers to specify in detail individual ingredients of beer which are liable from their origin or mode of preparation to be contaminated by arsenic, to prescribe for every such ingredient, and for the different materials used in their preparation, an adequate test which should ensure their freedom from arsenic, and to prohibit, under penalty, the use in a brewery of any material which infringes the prescribed test."

We at once considered that. The first thing which we had to determine was whether the Board of Inland Revenue did or did not possess the necessary powers. We were advised that we did not possess those powers, and thereupon we wrote to the Treasury drawing their attention to this recommendation, saying that we concurred in it, but that as we did not possess the necessary powers legislation would be necessary in order to enable us to carry it out. We suggested that, pending legislation, which certainly could not take place immediately, we might be doing a good deal towards getting things in order, so that when any Bill was passed we should have the necessary machinery in order; more especially in regard to determining what materials used in the preparation of beer ought to be scheduled for testing, and, further, what the test should be which those scheduled materials and ingredients should pass. The Treasury intimated their concurrence in that, but said that they wished to do something immediately, seeing that legislation might be delayed for a considerable time, probably until the presentation of the final report of the Commission. They informed us that they proposed to issue an Order under the Revenue Act of 1888 prohibiting the use in brewing of glucose or of invert sugar containing arsenic. That Order was issued in October, 1901, and simply prohibited the use in the manufacture and preparation for sale of beer of any glucose or invert sugar containing arsenic. That would give us power to seize any beer in which such materials were used, and impose a penalty of £50 upon any brewer who used it. We drew the attention of the trade to that Order in a circular of November 14th, in which we urged that, pending any further Orders, they should, at any rate, always insist upon a warranty with such articles, and we pointed out that any brewer who accepted materials of that class without a warranty would incur considerable responsibility. We further said that we should exercise much greater stringency in supervision in any case where we knew that a brewer did not require that warranty. I have already sent copies of that circular and of that Order to you, but I am not quite sure whether they have been printed, so I will hand in these.

Issue of Treasury Order prohibiting use of arsenical glucose and invert sugar in preparation of beer.

Sir H. Primrose.

Prohibition under Section 5 of the Customs and Inland Revenue Act, 1888, of the use in Beer of certain substances.

Whereas it appears to the satisfaction of the Lords Commissioners of His Majesty's Treasury that glucose containing arsenic and invert sugar containing arsenic are substances which are capable of being used in the manufacture and preparation for sale of beer, and that the said substances are of a noxious and detrimental nature.

Now the said Lords Commissioners, under the power conferred upon them by Section 5 of the Customs and Inland Revenue Act, 1888, do hereby prohibit the use in the manufacture and preparation for sale of beer of any glucose or invert sugar containing arsenic.

Dated this 10th day of October, 1901.

N.B.—A penalty of £50 is imposed by the said Section for any breach of this prohibition.

W. H. Fisher.
H. T. Anstruther.

Notice to Brewers of Beer for sale, and Makers and Vendors of Glucose and Invert Sugar.

5352-01 E

Inland Revenue Office,
Somerset House,
London, W.C.
November 14th, 1901.

The Commissioners of Inland Revenue desire to invite the attention of brewers of beer for sale and makers and vendors of glucose and invert sugar to the notice which was published in the "London Gazette" of the 15th ultimo, and of which a copy is subjoined. By this

notice the use in the manufacture and preparation for sale of beer of any glucose or invert sugar containing arsenic is prohibited.

The Commissioners are aware that precautionary measures have already been taken by brewers and by makers of glucose and invert sugar in this country, and they also understand that, in many instances, the delivery of these goods is accompanied by an invoice which contains a written warranty that they are free from arsenic.

The Commissioners hope that brewers will in no case accept delivery of glucose or invert sugar unless accompanied by such a warranty, and they think it well to intimate that the absence of such a warranty must materially increase the responsibility of a brewer, and must of necessity lead to greater stringency of supervision on the part of the Board's officers.

The object of His Majesty's Government in causing this notice to be issued is to ensure as stringent precautions against the introduction of arsenic into beer as are possible in the present state of the law, and of scientific knowledge as represented by the first report of the Royal Commission on Arsenical Poisoning.

In that report the Royal Commission recommended "that the Board of Inland Revenue should possess and should exercise powers to specify in detail individual ingredients of beer which are liable, from their origin, or mode of preparation, to be contaminated by arsenic; to provide for every such ingredient, and for the different materials used in their preparation, an adequate test which would ensure their freedom from arsenic; and to prohibit, under penalty, the use in a brewery of any material which infringes the prescribed test"; and the Board of Inland Revenue take this opportunity of informing you that they are engaged in considering the fuller measures that may be necessary to carry out these recommendations, or so much of them as His Majesty's Government may eventually decide to adopt.

The Board have reason to believe that the recommendations of the Royal Commission will meet with the approval generally of the trades concerned, and they trust they may count on receiving from their members co-operation and assistance in framing the details of any system that may be devised for carrying them into effect.

J. B. MEERS, Secretary.

(The copies were handed in.)

Then the next step was to issue instructions to our officers with reference to this Order. Those instructions dealt with what samples they were to take. The order was that they were to take one sample of finished glucose and one of invert sugar per month from each maker of these articles for examination as to the presence of arsenic. We have power to do that as regards glucose. As regards invert sugar, I think it has to be done, more or less, with the consent of the makers, but, inasmuch as invert sugar-makers and glucose-makers are commonly one and the same people, no difficulty has arisen in that connection. Then, as regards brewers, we ordered that one sample a month of the glucose or invert sugar should be taken from them, but only from such brewers as are known to receive imported brewing sugars without a warranty of freedom from arsenic. Having sampled freely at the factories, we did not consider it was necessary to take so many samples from the brewers, except in the case of imported sugar, where they did not accept a warranty. Those samples have been regularly taken in accordance with those orders, sent to the Government Laboratory, and there analysed. I hand in copies of our instructions.

Circular to Supervisors.

5352-01 E.

Inland Revenue,
Somerset House,
London, W.C.
November 14th, 1901.

Sir H. Primrose, 2 April 1903.

SIR,

The Board direct me to acquaint you that they have prepared a notice for issue to brewers of beer for sale and makers and vendors of glucose and invert sugar, calling attention to the prohibition of the use in the manufacture and preparation for sale of beer of any glucose or invert sugar containing arsenic; and I am to instruct you to cause a copy of the notice to be served without delay upon every trader concerned in your district.

The necessary supply of the notices should be obtained from the Controller of Stamps and Stores by application in the usual manner.

Further instructions as regards the taking of samples will be issued in due course.

I am, Sir,
Your obedient servant,
J. B. MEERS, Secretary.

Extract from Instructions.

12. Samples of Glucose and Invert Sugar.

In connection with the recent prohibition of the use in the manufacture and preparation for sale of beer of any glucose or invert sugar containing arsenic, the Board direct that one sample of finished glucose and one of invert sugar, per month, be specially taken from each maker of these articles, for examination for the presence of arsenic.

As regards brewers, it will be sufficient to take (in addition to the samples of materials at present taken for testing their brewing value) a sample, monthly, of glucose or invert sugar from such brewers only as are known to receive imported sugars without a warranty of freedom from arsenic.

Samples obtained from brewers using imported glucose if no warranty as to arsenic.

The samples should be taken and forwarded to the Government Laboratory in accordance with the regulations for sampling contained in the general instructions. The general label form 77-1 should be used, and the name of the maker and the words "To be tested for arsenic" inserted thereon, as well as in the advice letter. In the case of samples sent from breweries, the name of the importer or merchant, in addition to that of the brewer, should be given.

11845. *(Sir William Hart Dyke.)* That monthly taking of samples only takes place in those cases where the material is imported?—Yes; in regard to breweries, we should only take samples of the imported sugar, as a rule, because we have already sampled all the British factories, and, therefore, it did not seem necessary to take many samples from the breweries.

11846. But after the issue of this Order you have full powers to do so?—Yes, we certainly could do so.

11847. Your powers are full enough in regard to taking these samples monthly, when and where you like in the breweries?—Yes. I will now state the results of the sampling carried out in conformity with the above orders:—

Results of sampling.

(1) *Makers of Glucose and Invert Sugar.*—From these 185 samples of glucose and 224 samples of invert sugar have been taken. Of the 185 samples of glucose, 92 have been found free from arsenic, while 93 showed traces in no case exceeding 1-250th grain of arsenious oxide per lb. Of the invert sugar, 94 samples proved free; 127 contained less than 1-250th grain per lb.; while three contained more. In no case did the arsenious oxide exceed 1-100th grain per lb.

at British sugar factories;

(2) *Breweries.*—The number of samples taken, and the results of analysis, are shown in tabular form, as follows:—

and at breweries.

Sir H. Primrose.
3 April 1903.

TABLE I.

BREWING MATERIALS, &c., taken in the ordinary course of Revenue Supervision, examined for Arsenic.

NATURE OF MATERIAL.	Free from Arsenic.	Containing less Arsenic than 2/100 grain per lb. or 1/100 grain per gallon.	Reported as containing Arsenic as in Table II.	TOTAL.
Malt	137	169	22	328
Maize (flaked)	40	2	—	42
Rice (flaked)	9	—	—	9
Malted Wheat	—	—	1	1
Malt Flour	1	—	—	1
Flour	1	—	—	1
Linseed	1	—	—	1
Oat Husks	1	—	—	1
Malt Extracts	8	3	—	11
Yeast Foods	13	12	4	29
Hops and Hop Extracts	2	1	1	4
Preservatives (Regenerators, &c.)	6	6	4	16
Heading Powders and Solutions	3	6	—	9
Caramels and Colouring Matter	47	15	3	65
Cane Sugar	33	8	—	41
Priming	17	12	—	29
Glucose	168	130	2	300
Invert Sugar and Saccharum	52	65	—	117
Liquid Glucose Solutions	92	57	—	149
Brewing Salts	1	1	—	2
Liquorice	2	1	—	3
Beer Improver	1	—	—	1
"Dextrinous Material"	—	1	—	1
Beer, for Saccharin	6	10	1	17
Beer, War Office and Admiralty	34	4	—	38
Worts	1	3	3	7
Ginger Beer	1	1	—	2
TOTAL	677	507	41	1,225

TABLE II.

SAMPLES reported as containing Arsenic.

Date of Receipt of Sample.	Laboratory Number.	Article.	Amount of Arsenic reported.
22nd February 1902	8,846	Malt	1-80th grain per lb.
22nd " "	8,849	"	1-80th "
3rd March "	9,182	"	1-125th "
14th May "	264	"	1-166th "
26th " "	311	"	1-100th "
11th June "	376	"	1-150th "
18th " "	433	"	1-150th "
18th " "	434	"	1-160th "
7th July "	506	"	1-150th "
8th August "	784	"	1-140th "
15th " "	810	"	1-120th "
20th November "	1,198	"	1-100th "
21st " "	1,212	"	1-120th "
21st " "	1,213	"	1-120th "
27th " "	1,251	"	1-110th "
27th " "	1,252	"	1-90th "
17th December "	1,347	"	1-180th "
18th " "	1,358	"	1-100th "
9th January 1903	1,421	"	1-50th "
2nd February "	1,531	"	1-144th "
14th " "	1,553	"	1-144th "
14th " "	1,554	"	1-90th "
14th " "	1,552	Malted wheat	1-102nd "
26th July 1902	730	Malto-peptone	1-70th "
3rd January 1903	1,404	"	1-40th "
31st " "	1,524	"	1-70th "
26th " "	1,497	Peptomide	1-100th "
24th October 1902	1,115	Regenerator	7-10th grain per gallon.
8th November 1902	1,156	"	3-10th "
19th " "	1,374	"	1-1?th "
17th " "	1,339	Beer softening	7-10th "
21st July "	708	Glucose	1-120th grain per lb.
14th October "	1,079	"	1-40th "
13th November 1901	6,018	Colouring solution	1-40th "
24th April 1902	218	Caramel	1-4th "
3rd December 1902	1,273	"	1-5th "
2nd February 1902	1,530	Hop compo.	1-4th "
15th April 1902	9,172	Wort	1-70th grain per gallon.
10th January 1903	1,430	"	1-36th "
16th February "	1,589	"	1-36th "
12th March 1902	8,611	Beer	1-80th "

11848. (*Chairman.*) I notice you have not confined yourselves to taking samples merely of glucose; you have taken samples of malt, maize, and rice, and other ingredients used in brewing?—Yes.

11849. But the Order of the 14th November, 1901, mentions only glucose and invert sugar?—That is so.

11850. But in virtue of this Order, you have taken samples of other ingredients?—Yes; because under our general powers we have power to take samples of any material that is used in brewing. I have handed in two tables. The first table shows the number of samples taken, and classifies them according to the quantity of arsenic found to be present in them. Those that have been discovered to be entirely free from arsenic are shown in the first column, where it will be seen that there are 677 absolutely free out of a total of 1,225. Those in the second column are those which, though not absolutely free, contain arsenic in quantities less than 1-250th grain per lb., which would be equivalent to 1-100th grain per gallon of beer. That accounts for another 507 of the total of 1,225. The third column, which totals to 41 altogether, are those samples in which arsenic was found to a greater extent than 1-250th grain per lb. The samples in the first, which are absolutely free, and the samples in the second column we may regard, I think, as negligible. The only interest which attaches to the table is to the 41 samples in the third column. Then Table 2 gives a complete list of the 41 samples, with the quantities of arsenic found. It will be seen that the first 20 or so are all small. In all the cases in Table 2 where malt was found to contain arsenic to the quantity named, we always drew the attention of the brewers to that fact, and warned them that the malt was not such as ought to be used. I think in no case have we found any reluctance on the part of the brewers to recognise and accept our advice—in fact, they have, as a rule, thanked us for drawing their attention to it, and I think in every case we have been satisfied that the malt has not been used after they received our notice.

11851. I see the greatest quantity amounted to 1-50th grain per lb.?—Yes.

11852. How much would that amount to per gallon of beer?—About 1-20th. That is much the worst case. I have brought with me a certain number of papers, which show exactly what we did. We drew the brewers attention to this matter, and this was their reply:—

> "We thank you for your letter of the 16th inst., re malt, and beg to state we have only 1qr. 6 bushels of that especial malt, which has been sent to the stables for horse food, and will on no account be used in the brewery."

Probably, Professor Thorpe will remember that in this particular case the brewers sent samples to their own chemist, who gave rather a different result.

11853. (*Professor Thorpe.*) I do not remember about the different result. I know they did, as a matter of fact, have it analysed again, but I do not quite know with what result?—I do not attach much importance to it, because we cannot be quite sure that the sample was taken in the same way, or that the same quantity was tested.

11854. (*Dr. Whitelegge.*) Was the control analysis made after the Government laboratory examination?—Yes. The report of the brewery chemist is dated March 3rd, 1903, whereas the laboratory report is dated the 12th February, 1903, so that the brewery analysis was made nearly three weeks afterwards.

11855. (*Chairman.*) In the particular case, where so much as 1-50th grain of arsenic per lb. was found in the malt, was the origin of the malt traced?—No, not in that case; but there are several cases in which it was. In this case they did not mention where they got the malt.

11856. It was taken in a brewery?—Yes; but there is nothing said as to where it was obtained. Then, immediately below the malt samples, we give the samples of articles, of which many were submitted to us for permission to use. Among them are regenerators and malto-peptones. The latter, I suppose, is a yeast food. You will notice that there are three cases of malto-peptones; in all those cases we refused to allow the material to be used at all, and none of it, I think, was used, because they would have to obtain our sanction to its use before they could use it. In the first instance, they sent it up to us, and we informed them that it was not fit for use, and that they must not use it, so that none of it, as a matter of fact, would get into beer.

11857. What is malto-peptone, and what is it used for?—It is used as a yeast food—I do not know what it is composed of.

11858. Is it not used in brewing?—It is not used directly in brewing.

11859. Was this sample taken in the brewery?—Yes, all these samples were taken in the brewery.

11860. Did the brewers intend to sell it for other purposes than brewing?—No; they sent it up to us with an application to be allowed to use it. I think I have the correspondence in one case, which will show you exactly how the subject was dealt with.

11861. (*Sir William Hart Dyke.*) With regard to you prohibiting the use of this malto-peptone, have you full powers to prohibit the use of such an article?—Yes; there are materials of a kind that a brewer may only use with our permission under the ordinary law.

11862. (*Chairman.*) Was it for the purpose of brewing that the brewers wished to use the malto-peptone?—Yes, it was. This is a schedule of the samples sent. Two samples of malt, two samples of sugar, one sample of grain, and one sample of malto-peptone. Perhaps Professor Thorpe knows, but I believe we have sanctioned the use of the malto-peptone in a general way.

11863. (*Professor Thorpe.*) Yes?—Then it is not a new thing? When I said that none of these might be used, I should not have referred to malto-peptone; I was thinking of the next one on the table, the peptomide. But in this case they sent up malto-peptone with other samples, and we informed them that they should be acquainted with the presence of arsenic in excess in the malto-peptone, with a view to its immediate discontinuance in use and its removal, and the result should be stated. This is their answer:

> "January 14th. We are obliged for your letter, and have at once communicated with the makers. In the meantime, we have stopped using it, and had it all removed from the brewery premises."

11864. (*Sir William Hart Dyke.*) Would that prohibition in regard to this particular firm stay there, or extend to the trade generally?—It would only refer to this particular specimen. limited to particular specimens.

11865. Not to the use of the article, generally, in the trade?—No.

(*Professor Thorpe.*) Some malto-peptones are quite right.

(*Chairman.*) What is malto-peptone? Is it a substitute for malt?

(*Professor Thorpe.*) It is not a substance actually used in brewing; that is to say, in the conversion of the starchy matter of the grain to alcohol; it is used merely as a food for the yeast.

(*Chairman.*) How much of it would get into the beer?

(*Professor Thorpe.*) Very little, probably none.

(*Chairman.*) A small quantity would be used in connection with a large quantity of yeast?

(*Professor Thorpe.*) Yes. It consists mainly of soluble phosphate associated with nitrogenous matter.

(*Chairman.*) Has it anything to do with digestion? Peptone is something digestive?

(*Professor Thorpe.*) It is not peptone in that sense; it is simply a name given to the ingredient by the trade.

(*Chairman.*) What is the substantial value of it in connection with yeast?

(*Professor Thorpe.*) It is a sort of concentrated food which is given to the yeast to cause it to grow and multiply more rapidly than it otherwise would.

11866. (*Chairman.*) (*To the Witness.*) At all events, the use of these specimens was forbidden?—Yes, those particular things, and in every case they were at once removed.

11867. I notice there is another new name here—peptomide?—I think that is a preparation of the same kind. In that case we prohibited its use by the brewer, and we informed the maker also.

11868. Can Professor Thorpe tell us whether the use of this malto-peptone and peptomide are new-fangled methods in breweries?

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(*Professor Thorpe.*) No, they are pretty old now.

(*Chairman.*) But new names have been given to them?

(*Professor Thorpe.*) They are names given to these preparations of yeast food. Peptomide is somewhat similar to malto-peptone, but is prepared, I believe, from yeast; they are proprietary articles.

(*Chairman.*) Are they old things to which new names have been given?

(*Professor Thorpe.*) I should think they have been used for some years past; for 15 or 20 years, certainly. They are scheduled in the report, which Sir Henry Primrose will refer to, as ingredients or materials which are liable to contain arsenic.

Arsenic in beer "regenerator";

11869. (*Chairman.*) (*To the Witness.*) I notice there is a "regenerator" in the list which seems to be very rich in arsenic?—Yes. That, I think, is used for improving beer that has turned sour, or has been returned as sour. The regenerator is used with the object of seeing whether they cannot work it up in any way so as to make it fit for consumption. You will notice there are two cases in the list where the quantity was 3-10th. of a grain and 7-10th of a grain.

11870. (*Chairman.*) What is a regenerator?

(*Professor Thorpe.*) It is a very crude carbonate of potash, which is used to neutralise the acetic acid which is in the beer.

(*Witness.*) In the second case in which that large quantity of arsenic occurred in the regenerator we intimated to the brewer that we could not allow him to use it, and we also sent a letter to the people who had made it, warning them of the quantity of arsenic that it contained. We did that last December, but I cannot find that we have heard from them since.

(*Professor Thorpe.*) I can supply the members of the Commission with the facts of that case, if you have not them on the papers. The makers of that article, on receiving the letter from the Board, came to see me about it, and gave me the history of the whole thing. The material came from France, and they threw it back upon the persons who sold it to them.

In "beer softening" material;

(*Chairman.*) I notice there is a "beer-softening material" which contains 7-10th of a grain of arsenic per lb.

(*Professor Thorpe.*) That is used for softening the water.

11871. (*Chairman.*) Is that prohibited?

(*Witness.*) That would be prohibited. I have not the actual facts of the case here, but I fancy that would be one of the articles which they would ask us to be allowed to use.

11872. It would depend on what quantity of it was used as to how far it might poison the beer. If a very small quantity was used in a large quantity of beer it might possibly not cause the beer to be injurious to health?—Probably that would be the case—that only a very small quantity would be used for softening the water.

11873. For softening the water before commencing the mash?—Yes.

In glucose;

11874. Then the results of the analyses of samples of glucose, colouring solution, and caramel are given. In the case of glucose, I see that one sample contained 1-120th of a grain; that is about twice the 1-250th in the other cases?—Yes. In both the cases of glucose mentioned in Table 2 we warned the brewer. We instructed our officer to inform the brewer that the samples of glucose contained more arsenic than should be present, and instructed him to call the traders' attention to the laboratory certificate of analysis. The report received was: "Trader informed of the analysis; use of this glucose discontinued."

In colouring solution;

11875. I notice that the sample of colouring solution contained 1-40th grain of arsenic per lb. Was any order made with reference to that?—A very small portion of that would be used in a barrel of beer.

11876. So that probably that would not add 1-200th of a grain to the beer itself?—I should think not.

11877. Was that allowed to pass because it was a very small quantity?—I think in all the cases given in this table it may be taken that we have practically stopped the use of the particular material.

(*Professor Thorpe.*) I should like to make that quite clear. Because a substance is only used in a small quantity, we have never considered that a sufficient excuse for the use of arsenicated material.

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In caramel;

11878. (*Chairman.*) It appears from Table 2 that the samples of caramel were largely arsenicated; they contain ½ and 1-5th of a grain of arsenic per lb.?—Yes. In both those cases we informed the people that the substance was absolutely inadmissible for use in brewing.

In "hop compo";

11879. Then I notice there is a "hop compo" containing ½ grain of arsenic per lb.?—Yes. That was rather a remarkable case, because not only arsenic, but antimony in a very large quantity was present—25 grains per lb. We immediately sent an inspector down to the country place to thoroughly investigate the facts, and it proved to be the result of an accident. The material was made by a chemist, who also made horse powders—powders that are given to horses to make their coats shine—and he had apparently used the vessel in which he had been making the horse powders for making this hop compo.

11880. (*Sir William Church.*) Do you know what hop compo consists of?—I suppose it was a hop substitute. I have the particulars of that case, I think.

(*Professor Thorpe.*) I can supply you with the particulars, if you would like to know them. It consists of a large proportion of hops.

(*Sir William Church.*) The question I want to know is: did it contain hops?

(*Professor Thorpe.*) Yes, with a considerable proportion of an astringent bitter, chiretta, and tannic acid.

(*Sir William Church.*) I only wanted to know whether "hop compound" really did contain hops at all. I suppose it is probably made of inferior hops, which have lost their flavour, and then flavoured with another bitter.

(*Professor Thorpe.*) I know nothing about the quality of the hops.

(*Sir William Church.*) You did not estimate the amount of lupuline?

11881. (*Chairman.*) Is there any legal way of applying severe punishment for such a fearful piece of carelessness as preparing an ingredient for brewers in a vessel that has been used for arsenic and not washed?—The law does not give our Board any power. I do not know what power the local authority might have. Also, I do not know whether, under the laws relating to chemists, there can be any punishment for such a thing as that. When we sent our inspector we told him to at once put himself in communication with the officer of the local sanitary authority, because we felt we had no particular power to deal with it, and that our business was to set them to work to examine into it.

11882. Was the person who made this mistake a manufacturing chemist supplying materials to a brewery?—Not, I think, on a large scale. I will see what the report of our inspector actually was.

11883. (*Sir William Church.*) The chemist would only be liable to a civil action by anybody who was damaged by using improperly prepared material?—That, I should imagine, would be the case. This is what our inspector reported: 18 parts of hop, 12 parts powdered chiretta, three parts tannic acid. The following certificate had been given by Mr. Norman Tate, of Liverpool, dated 30th November, 1882: "I hereby certify that I have made a careful examination of A.B. Hop Composition, and find it to be composed of vegetable matter capable of imparting to malt liquors an agreeable bitter flavour, and of good keeping qualities. There is nothing of an injurious character present. I consider this compound to be a good tonic bitter, possessed of properties which render it an excellent substitute for hops in the brewing of ales and other malt liquors." Apparently, the sales in 1883 were upwards of 150. The purchasers were either brewers in a small way or agents. No name of any importance appears in the list. In the following year the sales fell off considerably, and the decline was still more marked in subsequent years, until on the 29th April, 1896, the credit sales appear to have ceased altogether. Since then a few ready-money sales of small quantities have been effected, but of them no record has been kept. Therefore, of late years it has been very little used. Since hops have been cheap there is no particular inducement to use it.

11884. Was that particular hop composition tested in February, 1903?—That is so.

11885. Was that a residue of an original composition, or has it been made up at different times from 1887

till 1903 in small quantities?—Yes; only in small quantities, I gather.

11886. Was it made by the same maker who made it originally?—Yes. He says the firm is highly respectable, and does a good business, but, apparently, largely in veterinary medicines of various kinds, and it was that which produced the accident. When they were first told of it they said they could not conceive how it happened. It was only on going into the details of their business that it was brought out pretty clearly that that was what had happened—that they had used the same vessel for this stuff that they had used for some of their veterinary compositions.

11887. That accident occurred in the establishment of the manufacturing chemist who sold it?—Yes.

(*Professor Thorpe.*) I should like to add that the arsenic was an impurity of the antimony. Arsenic, presumably, is not present in the hops or in the chiretta, or in the tannic acid.

(*Chairman.*) It presumably came in with the antimony?

(*Professor Thorpe.*) Yes. Arsenic is a very frequent concomitant of antimony. Most antimonial preparations contain small quantities of arsenic.

11888. (*Chairman.*) Have you heard of the case of a manufacturing chemist in London who very nearly caused the death of a son of Mr. Ludwig Mond by making a mistake in his factory through putting in arsenic powder instead of another white powder?—Yes, I seem to have seen something about it in the papers.

11889. I do not know whether an inquiry was held at the time, or whether there was any question of taking steps to prevent such an accident?—That would hardly come within our province.

11890. Knowing what the present state of legislation is, does it appear to you that some protective legislation is wanted to diminish the liability of such accidents?—I do not really feel able to speak about that. My impression is that there is already sufficient responsibility imposed upon chemists. They have to be properly qualified, and I suppose they have to take the consequence of any mistakes they make.

11891. And the mistakes their workmen make?—Yes.

11892. (*Dr. Whitelegge.*) Do you refer to the pharmaceutical chemists or chemists in the broader sense?—Pharmaceutical chemists.

11893. The manufacturer to whom you are referring was a pharmaceutical chemist?—Yes, he was. I do not know whether Dr. Thorpe heard anything more from the medical officer of health in that particular case.

(*Professor Thorpe.*) No.

11894. (*Sir William Hart-Dyke.*) In regard to the question of forbidding the use of these articles, as you have done, in brewing, will you tell us about what percentage of arsenic you take as dangerous?—I think, according to this classification here, we should not draw the attention of the brewer to a less quantity of arsenic than 1-250th grain per pound, or 1-100th grain per gallon.

11895. Speaking generally, that would be about the percentage?—Yes.

11896. Do you think there should be a fixed standard of the amount of arsenic which would cause danger to the consumer?—I do not know that I am very well qualified to speak about that. I should like, if I may say so, first of all to finish my evidence, and then hand in the report of this Committee on Tests, copies of which I have already furnished to the Secretary. The idea of the committee was to enable the Commission to form a judgment as to what should be said upon a point of that kind. The table on page 11 of the report gives certain graduated rates of arsenical contamination, and it would be open to the Commission to select some one or other of the degrees in that table as a standard for the tests to be officially prescribed.

11897. This report which you have handed in is for the purpose of assisting the Commission in coming to some conclusion as to a standard?—Yes.

11898. And you think it would be well for them to do so?—That is what the Board are hoping the Commission will do.

11899. Do you think if that were done on the authority of the Commission it would be of assistance to the Board in future in carrying out their duties of protecting the public from danger?—Yes.

11900. In your notice of November 14th to the brewers you mention, do you not, that your Board have been considering fuller measures which might be necessary?—Yes.

11901. And you indicate, do you not, what direction you think those measures should take?—That was intended to refer to the recommendation of this Commission that we should possess and exercise certain powers. That merely refers to the fact that we were considering whether we should take steps to obtain from Parliament those powers.

11902. The powers which we indicated in the first report of the Commission?—Yes.

11903. I think the Chairman put a question to you with regard to whether you should not possess some punitive power—for instance, in cases of gross carelessness, whether it would not be better that you should be able to signalise your authority more emphatically by having some power of punishment in such cases?—I do not think it would be easy to give us powers in reference to the makers of materials. Our powers, I think, ought to be limited to dealing with the brewers and the brewing trade rather than that we should go outside.

11904. In fact, you would not like, as regards administration—that is, the protection of the Revenue—to go outside your original sphere of duty?—No.

11905. You rather indicated, I think, when you first gave evidence before us, when you were pressed on the matter, that there would be a difficulty in dealing with this question?—Yes.

Action by Board of Inland Revenue as to arsenic and relation to revenue questions.

11906. I think you were rather afraid, were you not, that there would be grave difficulty in trying to go outside your duties as laid down by Parliament, if you were to go in for a crusade for the protection of the public against poisoning? I think you said another Department had better do that?—I think the view of the Board has always been that we should limit ourselves as closely as possible to what is our special duty, namely, collecting the revenue; but I admitted on the last occasion when I gave evidence, if I remember right, that inasmuch as the collection of the revenue creates a certain machinery, it might be usefully used for the protection of the public health in this matter, and that within reasonable limits I thought the Board ought to accept certain responsibility in that direction.

11907. Speaking generally, do you think what you have done already is about as far as you ought to go for the absolute protection of the public?—I think it is.

11908. I am not criticising what you have done—I think your Department have done a great deal—but do you think you have gone as far as you ought?—I think we have gone as far as we ought or as far as we can with the existing law. But I am quite in favour of amending the law so as to give the power that is contemplated in the first report of this Commission, of enabling us to require brewers to see that they use no ingredients or no materials that do not satisfy a certain test, and that having considered the report of this Tests Committee, and on the advice of this Commission we should then say that no ingredients should be used that would not pass such and such a standard in this table.

11909. That would be giving you much greater powers of administration, would it not?—Yes.

11910. It would be extending the supervision which you now exercise to a much greater power of administration?—It would give us this power, that in the event of our discovering materials in a brewery which did not satisfy the required test, it would enable us to lay our hands upon them. Our position now as regards malt is this, that however badly contaminated it may be, we have no power to do anything except to tell the brewer that if he uses it he uses it at his own risk, and in a bad case we should do as we did in one of the cases mentioned in the table, where the malt was very seriously contaminated—warn the brewer that he must not on any account use it, and unless he guaranteed that he did not, and satisfied our officer that he did not, we should communicate with the medical officer for the district, and then of course he would run the risk of having his beer sampled in the public-house.

11911. All the larger breweries have their own analysts, have they not?—Yes, I believe nearly all of them have.

11912. And therefore a letter such as yours of November 14th would have a great effect, would it not, amongst all the brewers in forcing them to take the greatest possible care in regard to their tests?—Yes. I think we

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have every reason to be sure that the brewers themselves would really welcome legislation and intervention on our part of that kind. It is to their interests to be protected from the risks of such another occurrence as took place two or three years ago.

11913. You are aware, perhaps, that under the Sale of Food and Drugs Act there is no power of doing what you are able to do in your own Department—there is no power of entry for the purpose of examining materials in the process of manufacture?—No.

11914. Either in food or in the case of a brewery?—Yes.

11915. But you are aware of the fact that the Sale of Food and Drugs Act gives the power of testing samples of the finished material?—Yes.

11916. Therefore, as regards yourselves and the Local Government Board, you have a power which very much exceeds anything which the Local Government Board possess under the Sale of Food and Drugs Act?—Yes, that is so.

11917. You have full power to test every one of those articles as you have done in this case, and although you have no punitive power, you can give a severe warning to the brewer in regard to the use of the articles?—Yes, we have a right to take a sample of any article in a brewery that is used in the manufacture of beer, and to test it.

11918. It may be outside the scope of your Department, but I should like to ask you a question on this point. You have had some experience in dealing with this question, but, of course, you are restricted to the brewing trade, I apprehend?—Yes.

11919. Do you think it would be a good thing to extend the powers of the Sale of Food and Drugs Act, so as to give the power of examining samples and of entry to the premises of manufacturers to the Local Government Board?—That is rather a big question. My personal opinion would be that if it were established that there was any real necessity for it, then I think perhaps it ought to be done, but I think it ought to be fully established that there is in particular cases such a risk to the public health that some sort of Government intervention and control is necessary.

11920. You think it would be a rather hazardous step to take unless there was some very obvious danger as regards poisoning or injury to the public health?—Yes.

11921. And that that should be well established first before we ought to ask Parliament to grant such an amendment to the Sale of Food and Drugs Act as would give a right of entry to premises at all times?—I do. After all, the difficulties of determination are very considerable. The consequences of a mistake, say, on the part of an analyst who condemned something on insufficient grounds, might cause very serious loss and great inconvenience.

11922. I suppose you have had much greater facilities placed at your disposal in dealing with brewers and others connected with the trade in the last year or two, after what has been termed the Manchester scare?—Yes.

11923. And you have found in several cases that the trade have been very anxious to meet you in every way, and give you every information and facility?—Yes, that is most marked.

11924. (*Sir William Church.*) Taking these two tables and leaving malt out of consideration, is there any reason that you see why the other substances should not always be absolutely arsenic free; these are things which the Revenue have allowed to be used in beer, in addition to what are the proper and normal constituents of beer?—Yes.

Certain brewing ingredients might be required to be free from arsenic.

11925. Is there any objection whatever to it being laid down that any of these substitutes, whether they be yeast foods, or hop substitutes, or preservatives, should all be arsenic free?—I think not, with possibly one exception, and that is glucose. I think, from the method of its manufacture, a trace of arsenic would very often appear, and that to get it absolutely free would be extremely difficult,-quite as difficult as, say, with malt. I suppose that with malt a very slight change in the fuel used and so on would produce a trace of arsenic in the malt. In the same way it is my impression that from the method of the manufacture of glucose faint traces of arsenic might be found in a very large number of cases; that is to say, if you insisted upon absolute freedom from arsenic in glucose you might have to reject very large quantities of that article which are really perfectly safe and harmless.

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11926. According to Table 1, only two samples of glucose contained more than 1-250th of a grain of arsenic per lb.?—That is so; but you see that a very considerable quantity, 130, did contain traces.

11927. But what is your opinion with regard to the other substances which are used in smaller quantities, and which are not necessary really in the production of beer?—I do not see any objection to insisting upon absolute freedom in their case. There is also this to be said, that they are used in very small quantities.

11928. That does not matter. It seems to me that in regard to peptomides and regenerators and beer softeners and colouring solutions and hop compounds, there is no reason why it should not be laid down that if used at all they should be absolutely arsenic free?—No, I see no reason either.

11929. Passing away from those ingredients, and considering the glucose and malt together, seeing that such a very large percentage of the materials that you have examined would give less than 1-100th of a grain per gallon in the finished beer, would there be any hardship in laying down 1-100th of a grain as the standard, so that allowing, as is going to be suggested to us to-day, a 25 per cent. margin for error by the analytical chemist, any beer in which 1-75th of a grain of arsenic per gallon was found, would necessarily be condemned?—I should say not. I think with these figures one would say that would not be an excessively exacting test.

11930. At all events, you say there would be no difficulty in brewers working to a standard of 1-50th of a grain per gallon?—No, certainly not.

No hardship in requiring a "standard" of 1/100 grain per gallon in beer.

11931. And you do not think there would be any real interference with the trade in making them work to a standard of 1-100th of a grain per gallon?—No. I think, looking to the very small proportion of the 1,200 odd samples that we have taken, which are, I think, very representative of the general materials used, and looking at the very small proportion of those that have, as a matter of fact, been found to contain arsenic equal to 1-100th of a grain per gallon, there would be no hardship in fixing that as a standard.

11932. Whether it gets in through the malt or through the glucose seems to me to be immaterial so long as your finished beer is harmless?—Yes.

11933. I suppose you would lay down as your standard for glucose a more stringent test than for beer. Glucose, I take it, is a substance that you can keep under observation much easier than you can malt?—Certainly.

Stringency of "standards" for glucose and malt.

11934. And, therefore, you might have a more stringent and more constant examination of glucose than you could of malt, and it would be desirable that the amount of arsenic that was allowed in glucose should be smaller than the amount which was allowed in malt?—It seems to me that you might have the same standard when converted into grains per gallon.

11935. I was proposing that you should have a still more stringent standard for glucose. Supposing 25 per cent. of glucose was used in brewing, I was proposing that it should contain, say, not more than would give 1-500th of a grain of arsenic per gallon in the beer?—I do not quite see it. Of course, as regards the use of glucose for other purposes than beer, it may be another question. As regards beer, would there be any particular object in fixing a higher standard for glucose than for malt with reference to the quantity of arsenic that would appear in the beer?

11936. There is no need for glucose to contain arsenic. Although it is likely to contain traces of arsenic, as we see from the table, there is rather a larger proportion which is returned as arsenic free than as containing arsenic?—That is so.

11937. And, therefore, as it is a substance over which you can easily keep a close inspection, why should there not be a fairly stringent test for it?—That is a point which may be worth considering. Looking to the insidiousness of arsenic, and to the difficulty of absolutely keeping it out from such an article as glucose, I think it would be rather hard upon the glucose makers to impose too stringent a test. I am rather inclined to think, as far as dealing with beer is concerned, it would be better to consider a standard with reference to wort or beer than with reference to the material.

11938. I am afraid I have not got the references.

but I think we have had evidence from glucose makers that there would be no difficulty in manufacturing glucose so that it would not contain more than an infinitesimal part of arsenic?—If that were so, I should see no objection at all. I am speaking without knowledge of what would be an unduly severe test on glucose makers.

11939. Do you think that if it were laid down that all beers containing more than, we will say, 1-75th or 1-50th of a grain of arsenic per gallon in the finished article should be destroyed or condemned, that that would impose any insuperable difficulty on the brewer?—No, I do not suppose it would.

11940. (*Dr. Whitelegge.*) I understand that the Committee's report is intended to prescribe certain tests, is it not?—Yes.

11941. Have you understood that in the sense of prescribing methods of analysis as distinct from prescribing standards?—Yes. I understand that the Committee recommend that particular method of analysis. I do not know whether it would be necessary to make it imperative, but I should think it would be better to require that the standard should be with reference to the method of analysis—that the standard should be understood to include the method of analysis as recommended in this report.

11942. But, given the methods of analysis which the Committee recommend, do you regard their report as proposing the standards?—Do I understand this as recommending the standards?

11943. Yes?—I understand the report to leave that open for further consideration. It gives the material for fixing a standard, but does not itself recommend any definite standard.

11944. Then, if I follow you rightly, you think the Commission should now consider standards upon which the Board of Inland Revenue might work?—Yes. What the Board are hoping is that the Commission, taking this Committee's report, will give some indication as to the scale of tests in the table on page 11 of that report, and suggest some one at which we might draw the line, and say that anything that would not pass it must be prohibited and not allowed to be used.

11945. The table on page 11 specifies different quantities of different groups of substances to be taken for analysis?—Yes.

11946. For example, 10 grammes of malt are suggested, but only 5 grammes of sugar; do you regard that as a suggestion that there should be a more lenient standard for the one than for the other?—No. I am afraid I am not sufficiently acquainted with the scientific part of the subject, but I understood that as merely representing convenient quantities.

11947. For the convenience of analysis?—Yes.

11948. But consistently with the general assumption that arsenic ought to be kept out as far as possible? I think you told us, in regard to the individual cases that have come under the notice of the Board, the smallness of proportions in finished beer should not be accepted as an excuse for a large percentage of arsenic in the ingredient?—No. I think we should have power to deal with the ingredients to the extent of being able to stop their use. I believe the brewing interests would prefer that for the purpose of legal proceedings there should be some stage in the process of manufacture taken as the point at which analysis should be made, preferably the wort stage. But, apart from the question of proceedings in the way of prosecution, I think we ought to be able to lay our hands, so to speak, upon articles that were largely contaminated with arsenic, and order them not to be used.

11949. Make it penal to use them?—Yes.

11950. Which would not be altogether consistent with an exclusive standard for wort or finished beer?—No, I should not have a wholly exclusive standard. As a matter of fact, I do not think there would be any real question of proceeding on the materials, because I cannot conceive that a brewer who was informed that certain materials were seriously contaminated would care to go on with them.

11951. In reference to malt and chemicals, the legal position is the same as it was before the Order of 1901 was issued?—Yes, the Order of 1901 only affected glucose and invert sugar.

11952. I understand that was an Order of the Treasury, not the Board of Inland Revenue?—It was an Order of the Treasury under the Revenue Act of 1888.

11953. If the Treasury had thought fit, I suppose there was no legal reason against going further and specifying other ingredients, such as malt?—No. I cannot myself see, if it was right to prohibit glucose or invert sugar, why you should not equally have prohibited malt. As a matter of fact, I think the reason why nothing was said about malt was that first of all not nearly as much was known then as is known now as regards the extent to which malt is capable of being contaminated with arsenic; and in the second place it was perhaps going too far; it was, in other words, imposing on brewers a task that was pre-eminently a difficult one of determining how and when and what things were contaminated. It would have applied to the whole of their materials.

Revenue officers have no right of entry on maltsters' premises.

11954. Have the officers of the Board of Inland Revenue power to enter the premises of maltsters for sale?—No, not maltsters.

11955. The tables which you have given us state the seriousness of the arsenic contained to two degrees; first, as I follow it, where the proportion of arsenic which it would impart to beer does not exceed 1-100th of a grain per gallon?—Yes.

Quantities of different materials prescribed for testing by Departmental Committee.

11956. And the other in which it does exceed that proportion?—Yes.

11957. I suppose that is adopted as a standard in a general way only, and it proceeds on the assumption that there is no other arsenic added to the beer?—Yes.

11958. So that if we had arsenic contributed to the same beer by different ingredients, the finished beer would contain far more than the 1-100th that the other ingredients might yield?—That no doubt might be so.

(*Professor Thorpe.*) Would you mind repeating the question; I did not hear it thoroughly?

(*Dr. Whitelegge.*) The finished beer might and must contain more than 1-100th of a grain if each of several ingredients were contributing at the rate of 1-100th of a grain.

(*Professor Thorpe.*) It depends on the amounts used I should like to point out with reference to that question exactly how these particular quantities in the Committee's report which were selected for testing were selected by the members of the Committee. I may remind the Commission that the general principle on which we went was that it had been proved that beer made with due attention to carefulness on the part of the brewer could contain and did contain less than 1-100th of a grain per gallon of arsenic. There seemed to be, therefore, no particular reason why a sample of beer should contain more, because it had been proved to us, by the analysis of a large number of samples, that a great many of them did contain less. Having determined that a sample of beer need not contain more, when manufactured with ordinary attention to care in the selection of materials, we then proceeded to lay down convenient amounts of the several ingredients, such that none of them when used in very much larger quantity than they conceivably could be used would contribute arsenic to the beer to the extent of 1-100th of a grain. The quantities of malt, for example, taken for the test, the quantities of invert sugar taken for the test, the proportion of hops taken for the test, the proportion of chemicals which may be used, preservatives, and so forth, are always far larger than would be present in a gallon of beer containing 1-100th of a grain of arsenic, so that, as a matter of fact, the individual tests applied to the ingredients are far more rigorous than they are either to the wort or to the finished beer. What I mean is, assuming that every one of these ingredients passed its test, then it is inconceiveable that the beer should contain an amount of arsenic up to 1-100th of a grain.

(*Dr. Whitelegge.*) Even if all contained a little arsenic and were added together?

(*Professor Thorpe.*) Yes: the finished beer or the wort would not contain as much as 1-100th of a grain.

Value to be attached to guarantees of glucose.

11959. (*Sir William Hart Dyke.*) Is there any evidence that guarantees given by importers of glucose, or their agents, can be relied on as a safeguard?—I do not know that we have any positive evidence on that point. Some of the manufacturers of glucose, certainly the largest manufacturer of glucose, has a well equipped laboratory and very competent chemists, and I should imagine that any guarantee given by him would be very trustworthy. I do not know to what extent other glucose manufacturers may do the same.

(*Professor Thorpe.*) I think you may inform the Com-

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mission that there are only seven or eight manufacturers of glucose, and that they all have chemists.

11960. (*Sir William Hart Dyke.*) I do not know whether you are aware of the fact that we have had evidence as to the way in which American glucose may be guaranteed. For instance, one witness states at Question 8794: "The merchant does not have it analysed, but he guarantees it in that guarantee to the broker. The broker does not have it analysed, but he guarantees it on the merchant's guarantee to the consumer. So that they guarantee a thing of which they have no personal knowledge whatever." I did not know whether you were aware of that?—No.

No drawback claimed on arsenical beer since 1901.

11961. Have you any knowledge in regard to the destruction of beer since 1901; have any brewers claimed rebate on account of beer which they found contained too much arsenic and consequently had destroyed?—I do not recall any cases of that kind; in fact, I cannot recall any case since the Manchester scare in which we have had an application. I think in one of the cases on that list a certain amount of the beer was destroyed, but they did not make any claim for the duty.

Court of Reference.

11962. We have had various recommendations regarding the establishment of a scientific court of reference to determine standards of purity in foods and food ingredients; do you think it would be an advantage to the Board of Inland Revenue, in cases where health questions were involved, to have such a body to refer to?—I do not feel that we ourselves are in need of such a body; I think we are satisfied with our own staff.

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11963. With reference to the precautions which you have taken in the last year or two, has that involved any addition to your staff?—No.

11964. You have been able to carry it out without any addition to the staff?—I do not think we have had to add to Dr. Thorpe's staff.

11965. (*Professor Thorpe.*) No, not in consequence of this?—We certainly have not added to the Excise staff

11966. (*Sir William Hart Dyke.*) Of course, if you had larger powers thrown upon you of administration that might involve an increase in your staff?—I do not think so, if we did not go beyond what the Commission has already recommended; I do not think it would add seriously to our work. After all, it only means taking a certain amount of samples.

11967. You have machinery there; that is the great point?—Yes, we have the machinery, and the mere existence of the machinery would probably prevent any great mischief.

Mr. ALFRED HENRY ALLEN, called; and Examined.

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11968. (*Chairman.*) You are an analytical and consulting chemist, and have been in practice in Sheffield for upwards of 30 years?—I have.

11969. You are a Fellow of the Institute of Chemistry, a Past-President of the Society of Public Analysts, and now a Vice-President, and you are Public Analyst for the West Riding of Yorkshire, the City of Sheffield, and several smaller boroughs?—I am.

11970. You have had an extensive experience in the analysis of articles purchased under the Sale of Food and Drugs Act, and have, within the last few years, analysed numerous samples of beer, with the object of detecting contamination by arsenic?—Yes. In many instances arsenic has proved to be present. The maximum quantity I have met with has been about one grain per gallon. In many instances the proportion of arsenic was very small, frequently under 1-100th of a grain per gallon, expressed in terms of arsenious oxide. In some other cases arsenic was detected, but the quantity must have been much smaller than that. I am prepared to detail, or, at any rate, to outline the method I used for examination, if it is of interest to the Commission, but otherwise it is on record. I do not know that I need trouble the Commission with the details of the process, unless Professor Thorpe desires it.

11971. Was the maximum quantity of one grain of arsenic per gallon found in the beer in which Bostock's sugars were used?—I do not know the origin of all the beers that came to me; they came to me under the Sale of Food and Drugs Act with numbers, and I have no means of tracing their origin.

11972. (*Professor Thorpe.*) From the local authorities?—Yes. There is no doubt that in some cases arsenic was present in the malt used, as we know it is apt to be on the outside of the malt; and in other instances I know that the brewers were customers of Bostock's, and that the beers must have been derived from Bostock's stock, but I know nothing about some other cases.

Arsenic in beer now brewed often below 1-700th or 1-1000th grain per gallon.

11973. (*Chairman.*) Ordinarily, at present, is the amount of arsenic in beer under 1-100th of a grain per gallon?—Since attention has been directed to the matter, the brewers and maltsters have been more careful, and it is much less than that, as a rule; in fact, I constantly report that I am unable to find any trace of arsenic. Since the trouble arose, brewers and maltsters have frequently sent samples to me privately to know whether they are free from arsenic, and the majority of them now show no arsenic reaction. Of course, if you took a sufficient quantity, I have no doubt you would obtain evidence of the presence of extremely minute quantities of arsenic, but I am speaking from a practical point of view; the amounts are below 1-1000th of a grain per gallon—quite insignificant.

11974. Could you tell it was below 1-100th of a grain per gallon; do you discriminate between 1-300th and 1-100th of a grain?—I can get indications, giving quantities roughly down to 1-700th of a grain. If it is something less than that, I talk of it as a 1-1000th of a grain, more or less.

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11975. What process of analysis have you employed?—I formerly employed a process of determination based on precipitation of the arsenic on metallic copper, as in Reinsch's process, resolution of the arsenical deposit by an oxidising agent, and distillation of the solution thus obtained with fuming hydrochloric acid and a reducing agent. The distillate contained all the arsenic in the form of arsenious oxide, and its amount was determined after neutralisation by titration with a very weak solution of iodine. The results by this process were very satisfactory, and I repeatedly proved the method to be capable of giving accurate results. It had, however, the disadvantage of requiring the use of a considerable quantity of beer, not less than 500cc. being requisite, and twice this quantity being desirable. Hence, at the time I employed this process, it became necessary to make small purchases of beer, with a view of ascertaining if arsenic were present; and then to purchase large quantities, at least one gallon, for the purpose of a quantitative determination, on which a certificate could be based. I have now abandoned the above process in favour of the Marsh-Berzelius method, employed with certain precautions. I think this process the best at present known, or, at any rate, it is the best known to me, for dealing with minute quantities of arsenic, and it has the advantage of being available with a very small quantity of beer. The results are only approximate, but this fact being recognised, they are sufficiently exact for practical purposes.

Use of Marsh-Berzelius method.

11976. I believe you were one of the members of the Joint Committee of Public Analysts and Chemical Industry?—I was.

11977. So that you have now had considerable experience of the working of the tests?—Yes. In other words, I was in the minority in using a modified Reinsch process; for a long time I could not succeed well with the Marsh-Berzelius process, but ultimately, with certain precautions, which I thought and think essential, I got excellent results, and have never had a bad result since. So that I have modified my opinion. I always regarded the process I used to employ as clumsy, and requiring an undesirably large quantity of beer; but now I can get good results, more satisfactory results, and, I think, quite as accurate results, by the Marsh Berzelius process with quite small quantities of beer.

11978. Do you get as satisfactory results by the Marsh-Berzelius process with small quantities of beer as you formerly got with large quantities by the Reinsch method?—Yes.

11979. As satisfactory?—As satisfactory.

11980. And as approximately accurate?—Yes, accurate enough for our purposes.

11981. Do you approve of prescribing any process of analysis officially?—No. I deprecate the official pre-

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scription of any process of analysis, however excellent, as being practically fatal to improvement in the future. Having in view the fact that the Marsh-Berzelius process is an arbitrary one, in which exact attention to details is essential, the personal equation in its employment is considerable. On this account, if any limit of arsenic is recommended by the Commission, it is desirable to leave a margin for unavoidable differences in the analytical results. Thus, should it be the opinion of the Commission that 1-100th of a grain of arsenious oxide per gallon of beer is the maximum amount which should be tolerated, the official limit recommended should not be less than 1-125th grain, thus allowing 20 per cent. of the total for divergencies.

11982. (*Chairman.*) You say the official limit recommended should not be less than 1-125th of a grain; should not that be not greater than 1-125th?—No, it is less; in other words, they should prescribe that the amount of arsenic should not exceed 1-125th, and, therefore, the limit should not be less than 1-125th.

11983. What principle do you follow in reporting on samples of beer?—In reporting on samples of beer, I am in the habit of stating that "the sample contains a material quantity of arsenic, I estimate the proportion of arsenic present at . . ." In the event of very small quantities of arsenic being found, I state that "A minute trace of arsenic was present, but the quantity was too small to enable any determination to be made." There are such things as very zealous authorities anxious to secure absolute purity of food and drugs, and sometimes one finds it desirable to certify in such a manner as to show that the quantity of arsenic is very minute; and, therefore, although one is bound to say one finds it, yet, if no determination can be made, it practically precludes any possibility of proceedings, and that is the reason why I have adopted these two alternative forms of statement in my certificates.

11984. When you estimate the proportion present at so much, do you mean to say it is less than, not greater than?—No; I give the result as obtained by the Marsh-Berzelius process.

11985. You estimate it?—I ascertain by analysis the proportion present at so much.

11986. Supposing it was so small as 1-250th of a grain, what would you say?—I should not have said that the quantity was a material quantity. If it were less than 1-250th, or down to that, I should, under usual circumstances, report that there was a minute trace present and avoid giving a figure.

11987. You say a minute trace present; by that, you would mean less than how much?—I think it would depend upon who I was reporting to, whether I was reporting to a sanitary authority or whether I was reporting to a brewer. In giving a certificate which a brewer can use, you want to inform him that there is arsenic there, and that he must take care; you want to convey to him that there is a trace in it, but it is so small that you cannot ascertain the quantity. That relieves his mind; but, at the same time, it makes him careful. But in the case of the sanitary authority, I should go a little further, and say the proportion was not more than a certain quantity. I have gone down to 1-500th of a grain, and 1-700th of a grain. I should state the actual figure to a sanitary authority, but, seeing that it is also said to be minute, that, of course, precludes practically any possibility of proceedings. Sometimes proceedings are apt to be initiated under the Sale of Food and Drugs Act, not on beer, but on other things on which the public analyst is not in any sense consulted, and on which they might have taken other steps to call the attention of the vendor rather than by actual prosecution, and one has to word one's certificate in such a manner as to be a guide to the local authority. In some parts of the Kingdom the inspector will proceed on any certificate which he thinks bears a construction that the article is not absolutely pure, and is not so well advised as he might be if he had to send all the offenders before a Committee, including the medical officer, and so on, who would be able to form a more decided opinion, and act, perhaps, with greater discretion. I have no doubt Dr. Whitelegge will appreciate what I mean in that way.

(*Dr. Whitelegge.*) Fully.

11988. With regard to articles of food other than beer, have you made any investigation?—Yes; but I have little to say, beyond what is probably already fully known to the Commission. I have strong reasons for believing that arsenical contamination has been due to other sources than Bostock's products and malt. Thus, I found a sample of confectioners' glucose syrup, of American manufacture, to be strongly arsenical. That was not Bostock's; and the man wanted to know at the time whether there was arsenic in the syrup. He said: "Is my glucose right?" He brought it to me to analyse, and it was very strongly arsenical.

Arsenic in confectioners' glucose.

11989. (*Sir William Hart Dyke.*) Was there much of a percentage?—I do not remember that I determined the percentage, but it was very strongly arsenical indeed, comparable, I have no doubt, to Bostock's samples; and I told him he must not use it.

11990. (*Chairman.*) Was that glucose syrup imported from America?—Yes. It is used by confectioners.

11991. I understand that you have not found arsenic in any samples of jam or marmalade?—No.

11992. Glucose is used in making jam and marmalade?—Yes. We used to think that marmalade was made with sugar and oranges, but the Lord Chief Justice holds that you can put in glucose, and practically anything else. There is no definition of marmalade.

11993. How is the flavour of marmalade given?—I think it is given by the oranges chiefly. As I understand, the old-fashioned way of making orange marmalade was with oranges and sugar; but the ordinary sugar—cane sugar—is now in part replaced by glucose; and the manufacturers say it keeps better because it is less likely to candy—the cane sugar is more liable to crystallise out, and that some people think objectionable. There may, therefore, be a good practical reason for partially replacing it with glucose. I am not in any way objecting to the use of glucose in that manner, only we have not got a definition, and we suffer so much in practice under the Sale of Food and Drugs Act from the want of an accurate definition of such articles as marmalade.

11994. Is glucose as wholesome as cane sugar in marmalade?—It is equally a heat-producing food, and it is equally wholesome in the ordinary sense, provided it has no arsenic in it. I do not see that glucose is in any way a worse food than cane sugar. To certain invalids glucose would be more objectionable than cane sugar, but we are not proposing to legislate for special invalid cases. I do not object to glucose, if by glucose we mean inverted cane sugar or something which is strictly dextrose; but there are varieties of brewers' glucose on the market which contain a large quantity of dextrin and indefinite substances, the nature of which is still a matter of dispute, and I do not like introducing indefinite substances into food.

11995. Does "right-handed" and "left-handed" discriminate betwen cane sugar and glucose?—No, not quite. If you invert cane sugar by an acid or other means, it splits up into a mixture of dextrose or dextro-rotatory glucose and lævulose or lævo-rotatory glucose in equal parts. That mixture is a thing which would be produced gradually by the action of an acid, perhaps, in the boiling of the marmalade; but, while you should not use previously inverted sugar, it may be desirable that cane sugar should become inverted in the preparation of the marmalade. I do not see any objection, from a physiological point of view, to the use of glucose, if by glucose you mean this invert sugar; but if you mean glucose such as is produced largely and employed in the manufacture of beer by the treatment of starch and starch-containing products with acids, then the products are different; you have no lævulose formed, but you have maltose formed, besides dextro-glucose, dextrin (a gummy substance of intermediate character), and more or less indefinite products, which we should like to know more about.

11996. Do you consider that even the best glucose is not so wholesome as cane sugar or as inverted cane sugar?—I should not like to say it is not so wholesome. I say we do not know all we should like about the glucose made from starch. We have certainly no evidence of ordinary glucose being injurious; the evidence is purely presumptive.

11997. Have you found arsenic in borax?—Yes.

Arsenic in borax: in glycerine, but rarely.

11998. And in glycerine?—As a rule, there is no arsenic in glycerine. I have had hundreds of samples of glycerine pass through my hands, and I think in only two or three have I found any arsenic. In one there was 1-20th of a grain per lb. 1-20th of a grain in a pound of glycerine is a very different thing from the 20th of a grain in a pound of sugar, because you do not

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take glycerine by the pound as a food, as a rule. Some people may take glycerine internally, but the quantity taken internally is generally very small, and, therefore, the 20th of a grain of arsenic in a lb. of glycerine is perhaps, after all, comparable to a tenth of that amount in a pound of sugar. But, still, there is no reason why the arsenic should be there, and I think we should aim in practice at getting food products as free from notably injurious substances like arsenic as we can.

11999. Can glycerine be called a food product, or is it, technically, a drug?—A drug is defined by the Sale of Foods and Drugs Act as a medicine for internal or external use by human beings. Carbolic soap is a drug in that sense. Glycerine is used as a drug, but it is also used in food. There are various preparations for invalids in which glycerine is used. In diabetic foods they employ glycerine as a sweetening agent instead of sugar. It is distinctly used as a food, and under particular circumstances might form a very essential part of food.

12000. (*Professor Thorpe.*) The modern definition of a food is anything that enters into the composition of a food, is it not?—Yes. It has been extended, in consequence of Mr. Justice Hawkins' view that baking powder was not an article of food.

12001. In the Act of 1899 food is specifically defined, is it not?—Yes. According to that Act, it is specifically anything used in the manufacture of food.

12002. As a food?—Therefore, tea-leaves would come under the definition, though you do not consume them.

12003. Glycerine jujubes, of course, would be a food?—Yes—or a drug; it does not matter which.

12004. (*Sir William Church.*) Glycerine is put into a large number of cakes by confectioners to keep them moist, is it not?—I have learnt that from Dr. Hammond Smith's evidence. I did not know it before, but, of course, I accept it at once.

Sale of Food and Drugs Acts insufficient protection against deleterious substances in food.

12005. (*Chairman.*) You consider the Sale of Food and Drugs Act, as at present interpreted and administered, does not afford a sufficient check on the introduction of deleterious substances?—I do, and for the following reasons. The authorities administering the Adulteration Acts have but imperfect knowledge as to the particular foods liable to be contaminated, and of the particular deleterious substances liable to be contained in such foods, and the public analyst is not systematically consulted as to the kind of samples which require investigation, nor is he generally cognisant of any systematic effort which may be made by the authorities. The samples sent to the analyst are distinguished merely by numbers. He reports the result of the analysis, and generally hears nothing officially as to any proceedings which may be taken. He may find reports in the newspapers if he keeps a very careful eye on them. He may, by writing to the inspector, learn what happened in respect to a certain sample. In many instances they are extremely remiss in informing the analyst of anything that has occurred. The public analyst is often in possession of the requisite knowledge with respect to substances liable to contain objectionable matters, but new forms of sophistication are continually being devised with the express purpose of escaping the public analyst, and it cannot be expected that all objectionable additions, whether accidentally or purposely introduced, can come within his knowledge. It is further, of course, out of the question to make an exhaustive examination of every sample submitted on the offchance or unlikely event of some unknown impurity being present. There seems to be an idea among the public that a public analyst has to make an absolutely exhaustive examination for every poison (and for every other substance not poisonous) of every article that comes to him. To us, of course, such a view is ridiculous; but the view is held, and sometimes public analysts have been accused of neglecting their duties, or executing them in a very perfunctory manner, because they have not gone out of their way to look for things which were not expected to be present. I am afraid I must plead that in the case of arsenic in beer. I never thought there was arsenic in beer until this Bostock case arose. I only had a sample of beer under very special circumstances, because we could not report on beer, as there was no definition of beer saying what it was to be made from, and unless you actually found something injurious there was no means of getting at the offender. Certainly it never occurred to me that people would use arsenical glucose, and therefore that arsenic would be found in beer, and I was equally ignorant of the now well-known fact that malt is liable to contain arsenic. I confess I was wholly ignorant on the subject.

Public analyst may not be consulted by local authority.

12006. (*Sir William Church.*) You only investigated beer for salt and water, and things like those?—That was so; and then the idea about salt being used as an adulterant died out, and the authorities said: "It is no use sending samples of beer. Really there is nothing to be done with them. We cannot prosecute for either one thing or the other, even for hop substitutes. What is the use, therefore, of knowing that beer contains these things if it is held that they are not illegal" Therefore until the arsenic question arose I do not think I had half a dozen samples of beer a year from all my authorities, and then if I had been asked I should have recommended them not to send them.

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Reason of beer being seldom sent to public analyst before 1900.

12007. In years gone by had you never had beer sent you to investigate for things like cocculus indicus and drugs of that sort that were said to be put into beer?—Under the Sale of Food and Drugs Act they do not send you the beer for special investigation or for investigation for a particular purpose. I receive a sample of beer, and I have to report whether it is "genuine." Many years ago I met with a beer taken under the Sale of Food and Drugs Act, of which a public analyst sent me a sample. It was before the days that Somerset House was made referee, so it is a long while since. I distinctly confirmed his conclusion that there was tobacco in the beer. I got very distinct evidence of it. I have looked in former days for cocculus indicus, and I have never found it. At one time I was actively interested in hop substitutes, and did find those, but nothing came of it. Of recent years I have never looked for such things as cocculus in beer, nor do I believe that they are used. In those days, when there were private brewers, and every little country publican at a public roadside house could brew his beer as he liked and from what he liked, there was a tendency to put in these things. Brewers' druggists went round and said, "Put in this, that, and the other, and it will do your beer good." But in these days, when the beer is almost invariably brewed in large breweries, where large quantities are made, and where the Excise officers are always around, and would spot a bag of anything wrong in the corner, I do not think that such things are used at all. Brewers are only too anxious to make a good, honest beer. They may say they make it cheaper from malt substitutes than from malt, but that we have had out before. My impression is that they are anxious to make a good article, and that we get a much better article than we did in the old times. I do not believe in these injurious substances being used on the sly. They cannot be used on the sly under present conditions.

Insufficient expert guidance of local authorities in collecting samples, &c., under Sale of Food and Drugs Acts.

12008. (*Chairman.*) In your opinion, any additional information respecting the liability of impurities, such as arsenic to get into articles of food would be welcomed, but I understand that past experience does not encourage you to believe that any central or local authority could be entrusted with the duties of collecting information?—That is so. The authorities are busy. The only officer they have whom they could consult, apart from the public analyst—who very often is at a distance, and is not present at their committee meetings—is the medical officer of health, and in some cases he is a busy man, with a great deal to attend to, and perhaps a private practice. In other cases, where the sanitary authority is a large one, he devotes his whole time to his duties, of which the purchase of samples under the Sale of Food and Drugs Act is a very limited part, and although he would be pleased in most circumstances to act on any hint or suggestion conveyed to him by the public analyst, it does not occur to him spontaneously that a thing wants looking into; and the authority are only advised by him. We really want to be better in touch with the sanitary authorities. One of the difficulties at present existing is that public analysts for different districts do not see each other's reports, and are not officially aware of the results of analyses in other distant parts of the country. In Sheffield I have, as an act of courtesy, a copy of the quarterly reports sent to me bound up with the Council Minutes, and I have it for my own satisfaction. In the West Riding I have a copy sent to me in the same way, and if I asked for them I could get two or three more copies; I do not think I could in Sheffield, because the quarterly reports there are included as part of a big volume. I never see my reports to the smaller boroughs; I suppose they send them up regularly to the Local Government Board—I have no doubt they do, as a

More co-ordination of work of public analysts desirable.

rule—but some of the authorities habitually lose them and ask me for copies. Ultimately they go up, but I do not see them, and I do not see other public analysts' reports. There are one or two cases where it seems to be the practice to publish a large number of copies in pamphlet form, and then the public analyst sends it to a few of his friends, but he cannot send it to everybody in the country, even if he has a list. The most complete list of public analysts was that in connection with the Sale of Food and Drugs Act handed in in evidence by Mr. Thomas to the Committee on Food Products Adulteration; but it was erroneous in several important particulars as to fees and terms of appointment; so even the Government have not got the particulars. Then, the annual report of the Local Government Board appears very tardily, and only summarises the adulterations met with in such a manner as to detract very much from its value. In other words, we learn only from the Local Government Board report—published, perhaps, a year or so after its nominal date—that Mr. So-and-So, of such a town, has found something as an adulterant. That is all we know about it. Of course, there is a certain amount of co-operation among public analysts—we have our Society's meetings, and so on, and there a good deal of chat goes on as to the way these things are done; but it would be very much better if the annual reports of public analysts, if not their quarterly reports, were published formally. Remember, the annual report is not a formal report—the law requires a quarterly report; but the annual report is a statement which the authorities are glad to have, because it enables them to see once a year what has been done, instead of wading through quarterly returns. A public analyst is under no legal obligation to furnish an annual report, although the local authority may like it.

12009. But he is under a legal obligation to furnish a quarterly report?—Yes.

12010. Could not the summarising in the quarterly report be thoroughly satisfactory instead of unsatisfactory, as you find it now, and so dispense with an annual report?—The quarterly report should be as full as it can conveniently be made, and I would suggest that it should be part of the regulations that it should be printed in sufficient numbers to enable the Local Government Board to send it round to all the other analysts, so that we might know what others are doing. Personally, I find that my annual report in the West Riding gives me an opportunity of commenting upon defects in the working of the Act, which opportunity I have not in the quarterly reports. We are tied down formally in a quarterly report more than we are in an annual report, I think.

12011. (*Sir William Hart-Dyke.*) You are speaking here of the provisions of the Food and Drugs Act?—I am speaking of the working of the Adulteration Acts, which term also includes the Margarine Act, and so on. I should be sorry not to have an opportunity of making an annual report. At the same time the quarterly report is the formal one which we are bound to make. You see sometimes a quarterly report is limited to a comparatively small number of samples, and you get a better purview really of the condition of affairs at the end of the year than you do at the end of the quarter. As a matter of fact, it has been my practice in the quarterly report to give a slight description of all adulterated samples, and to say the rest were genuine, and in reference to anything which has been specially interesting, I have generally paraphrased the wording of my certificate. In the annual report I give a table, which takes a very considerable time to compile, stating the number of samples of each particular kind examined during the year and their source, as there are a large number of sanitary authorities existing in the West Riding, each one of which is liable to send me samples. That makes the annual report a very troublesome one, and I am very glad I have not to give a quarterly report to these little sanitary authorities, who send, perhaps, half a dozen samples of milk a year. It would be a nuisance to have to make quarterly reports to them; but they are all included in the West Riding report. I do not grudge the trouble of compiling the statistics, because I think they are useful and valuable, and I should be sorry to be told, "Well, you must put everything you want to put in into the quarterly report," because, as I say, you do not get that general purview of the subject which you are able to get after a longer period.

12012. What is your view as to the analytical control in the case of arsenic and kindred impurities in foods?—I hold that the analytical control of the quality of food may be exercised more readily over the ingredients of a food than over the finished product, but the Sale of Food and Drugs Acts give no power to the local authorities to take samples or otherwise deal with food constituents at a factory where such ingredients are not on sale. For instance, in reference to this beer question, if local authorities, when Bostock's had their trouble, had had the power to go to other glucose manufacturers and say, "I demand some of your glucose," they would have been able to see at once whether other glucose manufacturers had got into the same trouble, or what kind of stuff they were distributing to their customers; but the process actually came to be this—that it was the finished beer that had to be examined, instead of preventing the arsenic from going into the beer, as the brewers would have been most anxious to do—the beer was finished, and then they had to run it down the gutters in some cases, or, as happened in one instance within my knowledge, put it aside till the scare was over, and then distribute it.

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Sale of Food and Drugs Acts give no power over ingredients where they are not on sale.

12013. When a retailer is prosecuted is there a difficulty in reaching the manufacturer?—Yes. First of all, the prosecution of the retailer often involves a distinct hardship. He is not always the man who is really to blame, and he has to defend himself under disagreeable circumstances. This is going a little away from the beer question, but in the case of many very well-known foods, and also in cases of arsenical impurity, the retailer is not responsible, really, for what he sells. The foods are very often done up in tins. Take the case of condensed milk. The importer, or the manufacturer, or the creamery man—the merchant—often puts on the can containing the condensed milk a grossly misleading statement as to its composition and misleading directions as to the use of the contents. For instance, in some cases they prescribe that these condensed milks shall be diluted with seven to ten parts of water for general use, and with 12 to 15 parts of water for babies. Now, there is no condensed milk in the market which is condensed to less than one-third of its original measure, so that to bring it to its original strength you should not put more than two parts of water, and then you would have the original strength. But these condensed milks which are preserved with sugar would be then of the thickness of thick cream, or even of treacle, and intolerably sweet, so that nobody could use them in tea unless they were very fond of sugar; and as for the baby using them, it is out of the question. Then, when the article is diluted to such an extent that the baby can tolerate it, you have got to fill its stomach with a lot of water; that is, give it very dilute milk indeed—deluged with sugar, which is a food, but, at the same time, you do not get the nitrogenous food or the fat. The result is that the directions on the tin, I consider, lead to the semi-starvation of children fed on condensed milk, where it is sweetened milk. Where it is unsweetened, a much more moderate dilution can be practised; but I do think it is a shame to lead people by label to suppose that they can get a good, wholesome milk of the original quality by adding a large quantity of water, even up to 14 parts, as is directed in a notable case. In any case, wherever you go beyond three parts, you have dilution of the original milk. Concentrated foods for invalids are also often very grossly misdescribed, but no means exist for local authorities proceeding against the prime offenders, since the sale of the article to the retailer takes place outside the district. I am not quite sure that I am strictly right about that, as I think it is possible perhaps that you might catch them at the railway station as they came in, in the same way as you can the milk; but the whole thing is eminently impracticable.

Penalties of Sale of Food and Drugs Acts do not reach the person responsible for the adulteration, &c.

Misleading descriptions of food, *e.g.*, condensed milk.

Difficulty in reaching the manufacturer.

12014. (*Sir William Hart Dyke.*) The manufacturer is in one district and the retailer in another district; that is your point?—Yes. That brings one really to the question of the warranty. A few weeks ago a man was summoned in Sheffield for selling adulterated milk. He pleaded that it was warranted as genuine, and he said he got the warranty from Liverpool. The Corporation summoned the Liverpool man who supplied him with that warranty and that milk, and it was argued for the defence—"You have nothing to do with us; we did it in Liverpool, and you cannot prosecute us in Sheffield for what we did in Liverpool." The stipendiary magistrate is taking time to consider this legal point, admitting

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that the law on the subject is somewhat intricate. Local authorities will not take proceedings unless they see their way clear. To have a case like that lost does very much harm, because every other adulterator says: "I have only to get the article and a warranty from a distance, and then they cannot touch him." The warranty is doing a most serious amount of harm in that way. The law, whatever it implies, does not distinctly say that the manufacturer or the merchant can be prosecuted at the same court where the retailer was originally brought up, and, therefore, it makes it impracticable. I will take the case of invalid foods as an instance. Some of these patent foods, which are grossly misdescribed, are sold in tins—they are closed preparations, and the retailing grocer or druggist does not know what is in them. He sells them over the counter for what they are stated to be. Yet if you want to prosecute, you have got to prosecute that innocent man, and then if he says, "I simply bought it from the wholesale man, and he described it on his invoice as being so and so," you cannot then summon the man from London down to Sheffield, because it is a different district, and the sale did not occur in Sheffield, but in London. At any rate that is the difficulty we are continually meeting with. There is a glaring case, which I think I mentioned to a previous Committee, of a patent invalid's food, described as containing over 80 per cent. of nitrogenous constituents. It was made chiefly of milk sugar, and wheat flour; it was worth perhaps twopence, and they charged 3s. 6d. for it. But that is not the point; let them charge what they like, but they should not misdescribe it. It was purposely misdescribed on an enamelled label, and they sold it largely. The Sale of Food and Drugs Act does not touch that kind of fraud. We want to have the power of summoning the wholesale man at the local police court; he is the man who really is at the bottom of it.

Objections to prosecution of mere retailer.

12015. (*Professor Thorpe.*) Why does not the Sale of Food and Drugs Act touch that particular case? It is not of the nature, substance, and quality demanded as by the label?—The wholesale man in Liverpool says, "You cannot summon me at Sheffield for an offence committed at Liverpool; I gave the false warranty in Liverpool, but you have nothing to do with that in Sheffield."

12016. (*Sir William Hart Dyke.*) That is a point of jurisdiction, rather?—It is, but at the same time it is one of the practical difficulties we suffer from. The warranties go from one man to another until they ultimately warrant them out of the kingdom, of course.

12017. (*Dr. Whitelegge.*) You have not had a hostile decision on that, have you?—We have not had a hostile decision, but there have been more than several instances where our authorities have not prosecuted, because they know the man has practically a warranty from a distance, and they say, "Well, we had better withdraw the case."

12018. (*Professor Thorpe.*) Take London, for example; surely there have been one or two cases in which the man giving the warranty has been attached to the prosecution, although he is outside the particular district controlled by the analyst who brought the original charge?—I do not know how far that would affect London: but I would point out a somewhat similar thing which occurred recently, where milk was taken to the analyst for the wrong district, and the case was dismissed because he was the wrong man to take it to, as the offence had been committed outside his district.

12019. I know that case. On the other hand, as a set-off against that, there have been one or two cases of adulterated butter, for example, when a particular analyst—we will say the Kensington analyst—has brought a charge against a certain retailer for the sale of butter which, in his opinion, is adulterated, and the man has pleaded, "No; I got this butter as pure, and under a warranty," and the court has attached the warrantor to the case, and conviction has followed, but nevertheless the warrantor has been outside the district of the particular analyst who brought the original charge?—That, I would suggest, shows that there is a difference in practice, and that the law is not clear on the subject. The Sheffield stipendiary is now taking time to consider the legal question whether the Sheffield authorities can take action against a person in Liverpool for a false warranty. That question was distinctly raised by the solicitor for the defence, who argued that the Sheffield stipendiary had no jurisdiction at all. The same difficulty has arisen before, and has within my knowledge prevented local authorities from taking action, because of the obscurity of the law on that point.

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12020. (*Chairman.*) Is the absence of legalised limits as to the amount of impurity allowed in food objectionable, in your opinion?—Yes; it causes much trouble in practice, and many failures of justice. The limit of strength in the case of spirits has operated very satisfactorily, but no limitation exists as to the amount of deleterious impurity allowable in such liquors. In fact, the whole question as to which of the subsidiary constituents of spirit are deleterious, and to what relative extent, is very uncertain, and would require lengthy investigation by experts before any legal limits could be fixed. The whole subject is highly complex, and its investigation does not come within the public analyst's duty, who, could he succeed in isolating the constituents which he might suspect to be injurious, is at once crippled by the Vivisection Act, which would prevent him administering a dose to a mouse to see whether it had any ill-effect. It is a thing which has not literally come to the point so far, but it is one of those things which would tell whenever he was required to express any opinion; and really it is important, because at present the examination of spirits under the Sale of Food and Drugs Act is limited practically to ascertaining the alcoholic strength, with the exception that I always look for sugar and for acids, which have been alleged to have been used, but which I have never found in the course of a quarter of a century's experience and many thousands of samples.

Need for "standard" and definition under Sale of Food and Drugs Acts.

12021. Water is the only adulterating material which is permitted, is it not?—Water is the only adulterating material which can be looked for under the circumstances under which samples are examined under the Sale of Food and Drugs Act. In the absence of any definition of spirits—of brandy, whiskey, rum, and so on—it would be quite impracticable to say it was not rum or it was not whiskey, except in a very special case. I have only recently certified on a sample which was labelled "Liqueur Rum," and on another which was labelled "Liqueur Brandy." They contained only a trace of alcohol, 20 per cent. of sugar, and flavouring matters, and yet they were sold as liqueur rum and liqueur brandy. That is so absolutely outside trade practice that I do not think there can be much doubt about a conviction ensuing under the Sale of Food and Drugs Act; but at the same time, with those very special and remarkable exceptions, it is only a question of strength. I may remind the Commission that in London the publican systematically evades the Act by putting up in his bar a notice, "All spirits sold here are diluted, but not below half-proof strength"; that is to say, he says everything here is adulterated, but is not adulterated to bring it below 50 under proof, whereas the legal limit for whisky, rum, and brandy is 25 under proof, and for gin 35 degrees under proof. He goes beyond that, admits it, and by means of a label or an announcement he can sell any dilution he likes.

Evasion of Sale of Food and Drugs Acts by means of notices.

12022. In respect to the sale of whiskey, rum, and brandy, you say the publican may give notice that it is diluted?—Yes.

12023. And he does?—He does so habitually.

12024. Is he within his legal rights in doing that?—A prosecution fails if you prosecute him, because he immediately says, "It was up in the bar parlour; I had a notice there, and I had it up in the bar." I would respectfully suggest that if you frequented London public houses you would find that notice was very general. The publican says: "All spirits sold here are diluted, but not below half-proof strength." That means not below 50 under proof, whereas the Act says you must not sell it below 25 under proof unless you sell it as a mixture.

12025. (*Sir William Hart-Dyke.*) That is without a notice?—Yes; but that notice is not understood by the frequenters of the bar, and it is perhaps not seen, and the law is evaded. It has been suggested that those licensed houses which exhibit such a notice should have their licence objected to in future, but there are so many other reasons now given for objecting to licenses that I do not know that it would hold water.

12026. (*Chairman.*) Do you not think that practice

* Since this evidence was given the Sheffield stipendiary has dismissed the summons on the ground of warranty, but without reference to the point of locality of proceedings.

of diluting these spirits is rather to be encouraged?—No.

12027. Providing notice is given, and providing he does not cheat the people by charging them more than he has a right to do?—I do not think the people understand the nature of the notice.

12028. (*Sir William Hart-Dyke.*) If you ask for a glass of gin, you may get gin and water?—Yes. As a strict teetotaler put it, I think they would be very much better without the spirit; but I do object to publicans selling water at the price of whiskey.

12029. (*Professor Thorpe.*) What you say is the constant practice in public-houses in respect to spirits is a growing practice in refreshment rooms in the case of milk; even refreshment contractors in railway stations put up a notice to the effect that "The milk sold in this establishment is diluted"; that is so, is it not?—Yes. They do that now on some railways. In the refreshment-rooms there is a notice to the effect that "In order to avoid any trouble under the Sale of Food and Drugs Act we beg to announce that all milk sold here is diluted," or "is not guaranteed to be genuine."

12030. (*Chairman.*) They do not say how much?—No. As a fact it is not diluted. They sell the genuine milk, but they want to protect themselves from annoyance.

12031. (*Sir William Church.*) What you do object to is that these diluted spirits are sold at the price that undiluted spirits should be sold at; and that does not seem to be right; it might be desirable that spirits should be sold weaker than they are, but then they should be charged less; that is your view?—I would rather put the water to it myself to the extent I wanted it. I think that some of these practical objections would be met if it were made part of the duty of local sanitary authorities to put the Merchandise Marks Act in operation in the same manner that they are entrusted with the taking of samples under the Sale of Food and Drugs Acts. At present it is no one's duty to put the Merchandise Marks Act into operation, and the sanitary authorities and the police consider it beyond the scope of their present duties. The other day the Danish Government representative brought an action at Leeds under the Merchandise Marks Act against a butterman for selling as Danish butter what was of Finnish origin, and got a penalty of £238. If it had been under the Sale of Food and Drugs Act in Sheffield, even if the man had been convicted, 10s. would have been as much as the man would have been fined.

12032. (*Chairman.*) How was this penalty of £238 arrived at?—I do not know how it was added up, but the Merchandise Marks Act gives very much heavier fines, and the practice is better—at any rate it is much more easy to obtain convictions under that Act than it is under the Sale of Food and Drugs Act. I do not think the warranty comes in except as a question of false warranty—he misdescribes his goods. Those instances I mentioned to you of invalid foods could be proceeded against under the Merchandise Marks Act if it were made the business of the local authorities to take action; but they say: "We have nothing to do with it, and we should be considered to be going outside our province if we were to touch the Merchandise Marks Act." The result is that it is useless. It should be made by law part of their duty to take proceedings, where they thought desirable, for false warranty and false descriptions, such as are practised now, and for which there is no penalty. Practically under the Sale of Food and Drugs Act you may misdescribe the article to any extent on a label, but that would not be the case under the Merchandise Marks Act.

12033. Do you think a Court of Reference whose duty it should be to recommend standards or limits would be valuable?—Yes, I should welcome a Court of Reference to recommend standards or limits and to formulate definitions. Such a Court would be valuable if properly constituted and endowed, but unless thoroughly representative, so as to have the confidence of all interests concerned, its appointment would be disastrous. As a matter of fact, the Society of Public Analysts suggested that a long time ago, and the Select Committee on Food Products Adulteration which sat in 1894-5 and 1896 practically adopted the suggestion, and thought a Board of Reference would be desirable, on which all large interests should be represented. Nothing, however, was done by the Government, and it has been omitted from the modifications of the Act which have since been made.

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Directions in which Sale of Food and Drugs Acts are unsatisfactory.

12034. Do you consider that the Sale of Food and Drugs Acts are in a satisfactory or an unsatisfactory condition?—In many respects I think they are in an eminently unsatisfactory condition. The Government, the judges, and the magistrates alike combine by their actions and decisions to encourage adulteration. I do not, of course, mean intentionally, but that is the practical effect of it. As an instance of the condition of the Acts, in the case of Mason v. Cowdray (Q.B.D. 1900, p. 419) six twopenny bottles of camphorated oil were purchased, and two of these were left with the vendor, two sent to the analyst, and two retained by the inspector. It was pleaded that there had not been a proper division into three as required by the Act, and that to send two complete bottles out of the six samples to each of the different people concerned was not right—they ought to have divided up a single bottle. In his decision Mr. Justice Ridley said it did not matter that the sample purchased was a small article. Six bottles were six articles. The appellant bought six bottles, and did not divide any of them. In that case the attention of the Local Government Board was drawn to the circumstance, and they replied that there had been a paper recently published saying that it was possible to ascertain the amount of camphor in camphorated oil with as little as one-sixth of an ounce—I have the correspondence here if it would interest you—and therefore it was not impracticable to divide the contents of one of these little twopenny bottles into three and submit it for analysis. The adviser to the Local Government Board did not take into account the fact that penny bottles were sold as well as twopenny bottles. The public analyst would always wish to repeat his analysis; in each case he would want another quantity. He is expected to report upon, and does habitually report upon, not simply the amount of camphor, but whether the oil present is wholly olive oil, as it ought to be, or is a mineral oil or is cotton seed oil, or some other oil. He cannot do that with only one-sixth of an ounce to work on. The same principle applies to pills, lozenges, sweets, and each blue and white packet of seidlitz powder. The decision means this: that if you buy pills, each pill is a separate article, and so you have got to divide that pill into three, and send one portion to the analyst, and so on. The result is that in the West Riding (where they were anxious to go into these matters, and did send to be analysed such things as bismuth lozenges, which very often contain only half the proper quantity of bismuth, and other things of this sort) every part of the Act to which this decision has applied has fallen through absolutely. It is no use buying samples and then having such a decision as this brought against one. It is deplorable that a large class of articles are not capable of being touched in consequence of such a decision. I mention that as one of the working troubles of a public analyst, not that it matters to the public analyst personally, except as a zealous officer. He, as a public analyst, is only too glad not to be bothered with this. The sanitary authorities who would like to do their duty cannot proceed against people who are misdescribing lozenges and so on because of such a decision.

12035. (*Sir William Hart-Dyke.*) I think you have told us that almost immediately after what has been termed the scare and loss of life owing to the Bostock case, a great change for the better took place as regards the samples which you had to analyse?—Of course, at the time one received from brewers and also from sanitary authorities various beers containing more or less arsenic, but the brewers were most anxious to avoid anything of that sort, as it was a most serious matter to them, and they had never meant it, and so they righted matters, most of them perfectly honestly, by destroying the beer which was contaminated with arsenic. There were exceptions in the case of people who put such beer aside until they could sell it off gradually.

12036. Even up to this date I presume you would admit that the brewers are most anxious in every way to take every step for security?—Yes, undoubtedly.

Precautions against arsenic may become lax if no adequate official control.

12037. But supposing in process of time more careless methods supervene, you would wish, would you not, for something to fall back upon for the complete security of the consumer?—Yes; I think the beer should be habitually looked into, so as to be quite certain there has been no relapse. Of course, we must recognise that the Bostock arsenical contamination was not intentional. I do not call it an accident, because it was worse than an accident, but nobody meant to put

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arsenic in the beer, and it has been such an experience to brewers all round that they will be very careful in the future. But there are some of them who do not realise that, and, as I say, I know an instance where it was arranged to pass off highly arsenical beer when people were not so actively on the look-out for it.

12038. You suggest that public analysts should see more of each other—that they should meet oftener and compare notes in their various reports?—Yes, I do. Of course, spontaneously they do that; we meet once a month as a Society; but then those go who like, and you must remember Great Britain is a large island, and that Ireland is also included in our membership. The United Kingdom is too large for all our members to come to London every month for a meeting. What I suggested was that machinery should be contrived by which they should be made aware of, and could judge, others' work in certain directions. If a man has got anything of considerable interest, he may bring it before his brother analysts at his Society; but that does not apply to the everyday work he is doing—how he has found three samples of such and such a thing to be adulterated. It may or may not be of purely local interest, but at any rate other analysts never know of it until they see in the Local Government report, which is published very tardily, that some public analyst has found something adulterated in an unusual or unique manner.

12039. I suppose you compare, do you not, your different systems and methods of analysis?—Undoubtedly we do, and a very great good has come from collaboration and consultation, from rubbing shoulders together like that; and I think it is very highly appreciated. But you must remember that that is simply informal, and that there is no official machinery for our making these things known to each other.

Margin to be allowed for unavoidable differences in analysis.

12040. You have informed us that, supposing that standard were fixed, whether it be 1-100th grain per gallon or whatever it might be, you consider that a margin of 20 per cent. should be allowed to cover the difference of analysis; that you have given to us as your opinion, but are you able to say that that would be about the general opinion of practised analysts?—I have not consulted them actually on that point, but I think so. In other words, we should be dealing in the Marsh-Berzelius process, with an arbitrary process, with a certain amount of personal equation in it—dealing with the depth of colour of the arsenic mirror, on glass; and I can quite understand that two analysts, working on the same beer, could obtain one, we will say, the 100th of a grain per gallon, and the other the 80th of a grain per gallon. That is a difference of 20 per cent. I can imagine making that difference myself at intervals of a few weeks. Therefore we must not expect different analysts to work more closely than oneself. The process is only approximate; it is quite good enough for practical purposes if it will tell you whether it is an 80th or whether it is a 100th of a grain; but I should not like to have a limit fixed, and then find that the amount of arsenic had exceeded that limit slightly, and that we were bound to report the beer as containing an excessive quantity of arsenic when it might, after all, be only a question of the personal equation. I would rather fix the official limit a little lower.

12041. If it became a question of penalising the manufacturer, of course, you would admit that the more nearly you can approach accuracy in the analysis the better, surely?—Undoubtedly. The best method of analysis is that which is most accurate; but there must always be a margin left. Supposing you go and fix the 100th of a grain officially, and supposing I were to find not the 100th of a grain, but rather more—the 90th of a grain—should I say that I am going to condemn this? It is within the limits of error, and it is not good enough to take into court, with a wholesome fear of the Government Laboratory before our eyes. The personal equation might cause a variation to that extent.

Arsenic in confectioners' glucose.

12042. You have mentioned the case of American glucose which you analysed and found strongly arsenical; have you examined many samples of glucose since that period?—Not of confectioners' liquid glucose. That was a liquid preparation used by confectioners.

12043. You have not found other samples of glucose equally contaminated with arsenic since that?—My experience of American glucose, I think, is limited to that one sample, at any rate so far as I know their origin. One does not get to learn the origin in many instances. I may say, from some independent source—I cannot remember at the moment how I know, but it is within my knowledge—that a good deal of the American glucose is arsenical.

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12044. You have heard that by report?—It is by correspondence with a chemist-friend in America, I think. I dare say I could ascertain where I got the information from, but I do not remember and cannot tell you at the moment.

12045. As an analyst of very long experience, may I ask you this general question: Do you think from your experience that there is sufficient danger to the public at present existing in confectionery, or in all other articles of food, apart altogether from the brewing trade, to suggest that there should be a strengthening of the Food and Drugs Act in order to protect the public?—From arsenic.

Advocates control over food manufacturer.

12046. Yes, from arsenic?—I think it would be well if you could deal with the manufacture of the food product rather than the actual food. You see, where it is not on sale the inspector has no right of entry.

12047. Would you like to see that done?—I should like to see that done, and I should like to see these things habitually and systematically examined. We have got our eyes open now, and I think the local authorities will many of them be alive to it; but you must remember that many of the smaller local authorities consist of members whose sons and brothers-in-law, and so on, are the tradesmen of the town.

12048. (*Dr. Whitelegge.*) Are there any standing official instructions available, let us say, for a new medical officer of health or a new inspector, as to the range and amount of samples to be taken?—I do not know of anything of the sort. Of course, we have the old pious opinion of the Local Government Board that there should be at least one sample per annum per 1,000 persons. I think that has been modified since.

12049. I gather that the Local Government Board had taken rather a stringent view of this?—Yes. I think the Board of Agriculture have expressed the same opinion.

12050. That would be as to the number of samples?—Yes.

Official instructions to nature of samples to be taken.

12051. Has anything been laid down officially for the guidance of the officers concerned as to the bulk of a given sample?—Take the case of my own experience. In the West Riding of Yorkshire I was asked, in the time, I think, of the previous medical officer of health, to say what amounts I should require for analysis (which, of course, would be at least one-third of the total quantity purchased), so as to make out a list for the inspectors of the kind of articles which could be advantageously purchased and the amounts they were to purchase. Those were the printed instructions which the inspectors were given, and those have been modified from time to time.

12052. They were for the West Riding only?—Certainly. I should say that is the best way, because another analyst might have his own particular ideas based on his own particular methods of analysing, and might say, "I require so much of a sample," whereas I might find it desirable to have double that quantity or half that quantity, according to the way I worked. I would rather the instructors were instructed to purchase what I thought desirable, or, rather, three times as much as I required, than to have it laid down formally from the Local Government Board. For instance, it has been held by one of the Government Departments, I do not know which, that all samples should be put into stoppered bottles. Of course, that is a provision which could not have been very practical. In the first place, a stoppered bottle would require to be tied up and sealed, and you might have to do that in a gale of wind, which is not an easy thing to do. Then a stoppered bottle is not so tight as a corked bottle under many circumstances. Certainly in the case of spirits and milk, I would rather have them contained in a well-corked bottle than in a stoppered bottle. In practice what we do is to use a corked bottle and to seal the cork properly, and put a label on the bottle, and enclose that in an envelope having only one aperture, which itself is sealed on the outside. That does not prevent tampering, however; we have had cases of tampering with samples of a very serious kind sometimes.

12053. Is it within your experience that in the absence of any definite instructions, local or general inexperienced officers of the local authorities send samples which are inadequate for the purpose?—Yes; sometimes too small an amount is sent. We had, so

I say, in the case of beer, to take small samples with the view of seeing whether there was any arsenic there, and of then getting a larger sample with all the formalities of the Act for a more complete examination, but that difficulty has been overcome since the adoption of the Marsh-Berzelius process, by which we can work with much less. Then, of course, you must remember that the beers examined of recent years were examined only for arsenic, and not with a view of making an examination for anything else. We have nothing to do with whether it is all malt or whether the bitters are all hops, or anything else. We are not in the habit of finding definitely deleterious matters in beer except arsenic, and therefore recent examination has been limited to that, in the same way that the examination of spirits has been limited practically to water.

12054. You have suggested that more might be done in the way of utilising the reports of public analysts; would there be any difficulty in doing that without any legislation? If, for example, the central authority had an expert adviser, would it not be practicable to summarise the reports annually in such a way that the information contained in them could be made available for all public analysts and for the public at large?—Yes, I think that would be quite practicable. As a fact, if it were made my business to do it, and I were an official adviser of the Local Government Board, knowing what would be important and interesting to my brother analysts, I think I could write a valuable and interesting resumé of the work done by them.

12055. Would that not be better than circulating the whole of the reports of each analyst?—I think it would be more practicable. What I suggested in examination-in-chief does imply a lot of waste paper, there is no doubt.

12056. You have said, I think with reference to the suggestion of a Court of Reference, that it would be good if all interests were adequately represented?—Yes.

12057. Would that mean interests in every branch of manufacture concerned, or do you mean that in addition to the official element and the scientific element there should be a representation of the manufacturing interest?—Without entering into details, my idea had been that, broadly speaking, the interests chiefly concerned should be represented; for instance, we ought, as a permanent member, to have the chief chemist of the Government Laboratory. Naturally a representative of the public analysts, if not nominated from among themselves, should be nominated by the Local Government Board—in fact, I would suggest a public analyst nominated by the Local Government Board and another one nominated by themselves, the Society of Public Analysts.

12058. My main point is that you do not consider that every branch of manufacture should be individually represented?—No.

12059. That would not be practicable?—I think the agricultural interests, the Dairy Farmers' Association, or whatever it is that represents milk, might very properly be represented. I can undestand the Chamber of Commerce being represented, and certainly the Pharmaceutical Society, or preferably druggists and pharmacists generally. You must remember that the Pharmaceutical Society does not by any means include all or even the majority of pharmacists; it is only a society which consists of a fraction of the practising pharmacists. The pharmacists ought to be represented, no doubt.

12060. The main interests should be?—Yes.

12061. Would you suggest in addition to other functions that such a board should have power to define articles to be used as food—marmalade, I think, was an instance mentioned?—Yes. They could do a great deal of good work. At present the public analyst is crippled because there are no definite limits as to how far accidental impurities can be tolerated, and that makes it very difficult indeed. The result is that the local authorities say, "We cannot proceed upon this; here is 3 per cent. of sand in so-and-so"—it is probably shop-sweepings—"but if we take that into court the magistrate will say that the vendor would not adulterate for the sake of 3 per cent. extra profit." They take that view, whether it be reasonable or not, and the result is that proceedings are not taken against that man. The chances are that if there are 3 per cent. of what analysts call sand in an article, that means a good deal more of extraneous matter, which proves the really bad quality of the article. But such cases as that are allowed to go through for want of a guide.

12062. Would it strengthen the hands of the local authorities in a case of reliance on a warranty for defence if the person alleged to give the warranty could be associated compulsorily in the same hearing and in the same case?—I should think that would be a very valuable provision. If a man was going to plead a warranty and gave a notice to that effect, the warrantor should be associated with him in the prosecution, so that the case could be heard at the original court where the retailer was summoned, and the whole case could be decided—whether he had given a false warranty or not. As I have pointed out, it is very questionable as to whether you have a legal right to summon a warrantor at a distance to the particular district police-court. It is held by some magistrates, at any rate, that the 28 days' limit must be accepted, and that you have got to take proceedings (because that is a new proceeding) against the warrantor within 28 days from the original purchase of the sample. This is very often quite impracticable. Perhaps the original summons is heard, we will say 20 days after it was issued—if it comes on as soon as that it is a wonder—they have to give a fortnight's notice, first of all, before it goes into court; but we will assume that to be the commencement of the proceedings. Then perhaps there is an adjournment—for perfectly legitimate reasons—bringing it to five weeks; and then the twenty-eight days' limit has expired, and you cannot proceed against the guarantor.

Question of attaching warrantor to prosecution.

12063. If you are bound by the 28 days, that is so. I gather you are of opinion that the local authority ought to have more power to visit a factory where foods are manufactured?—Yes, I think that if they had had the opportunity of visiting glucose manufacturers in connection with this beer disaster, they would have been able to stop it, instead of its being innocently introduced into beer by the brewers and then their getting into trouble afterwards.

12064. Do you think that only the local authority for the district in which the glucose manufacturer is situated should have the right to do so?—I should not like to say that, because the local authority might never exercise the power.

12065. But there would be a practical difficulty, would there not, in giving a roving commission to every local authority?—The question is whether, arsenic being so important, it would not be well to have a travelling inspector looking always into the question of arsenic and its sources.

12066. To deal with arsenic as a particular case?—Yes. Local authorities are very difficult to move, and the Food and Drugs Acts Inspector has got his own work to do, and he does not want to be bothered with extra work. I should be almost inclined to think, as it is so very important, that a special official might be appointed, who would then, I presume, submit the samples to the local analyst.

12067. I gather that your general opinion is that in beer there is no real justification for the presence of arsenic in any quantity above the 100th of a grain per gallon?—I think the 100th of a grain per gallon will cover all unavoidable traces of arsenic. As a matter of fact in practice they contain much less than that, but it is a question for the Commission to consider how far they are to be bound down to absolutely exclude these minute traces.

Beer should be well below 1-100th grain per gallon limit.

12068. I only wanted to have the benefit of your experience in the examination of beer samples. Your opinion would be that there would be no hardship in tying down the brewer to turn out a beer containing not more than the 100th of a grain per gallon?—I do not think there would be any hardship at present. Now he does it habitually, and is anxious to have as little arsenic as possible.

12069. We have not had quite a definite suggestion in reference to the food products; speaking broadly, are there any food products of the solid kind which could not fairly be tied down similarly to a limit of the 100th of a grain per lb?—That is a difficult question to answer. I have in mind a case within my own knowledge which I think the Commission will have an opportunity of hearing about from a brother analyst—I do not know that I am at liberty to mention it. It is a case where a substance has been added as colouring matter to a mixed food product—an artificial food product—this colouring matter being perfectly unknown to contain a large quantity of arsenic; but it does contain very material quantities of arsenic, and therefore has contaminated the food product. A colouring matter might

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contain a trace of arsenic, and you have no right to consider it as the 100th of a grain per lb., which is a very minute dose in a colouring matter, seeing that when it has entered the food product it only constitutes a very small quantity of the food product. I think it would be infinitesimal then. There is no evidence that this particular food has done any harm, but it was being made with a highly arsenical colouring matter.

12070. My question was rather directed to the food product, and not to the ingredient; the case you mention is one of an ingredient?—Yes.

12071. I suppose you would say, would you not, in advising a manufacturer, that he must keep out arsenic as far as possible, however small may be the proportion in which that colouring matter is going into the food?—Yes; and the manufacturer in this case, being advised and now having become aware, is taking the very greatest care that he does not introduce any arsenic, because if he went to an ordinary analyst and he found arsenic, that analyst would be perfectly right to report that it was present. An inspector would have been the manufacturer's best friend practically; the merchant's attention would have been called to the source of the impurity, and it would never have gone into general distribution. He would have been told, "That colouring matter that you are using is unfit for use in food, and undesirable for use in food."

12072. (*Professor Thorpe.*) I see—and I quite understand why—that you deprecate anything like the use of official methods being prescribed. I do not know whether you are aware of the interim report of the Commission; have you read that?—No, I have not had the opportunity.

12073. It has been published and circulated. There the Commission recommended that "the Board of Inland Revenue should possess and should exercise powers to specify in detail individual ingredients of beer which are liable from their origin or mode of preparation to be contaminated by arsenic, to prescribe for every such ingredient and for the different materials used in their preparation an adequate test which should ensure their freedom from arsenic, and to prohibit under penalty the use in a brewery of any material which infringes the prescribed test." The recommendation in Paragraph 34 was really directed to this, and it runs as follows:—"We are of opinion that by requiring the brewer to produce satisfactory evidence (whether in the form of a guarantee from the vendor or as the result of analysis by the brewer's chemist, stating in such terms as the Board of Inland Revenue may determine) that the prescribed tests have been applied to all the ingredients of beer at the brewery which have been specified as liable to contain arsenic, and that by the examination of samples in the Government Laboratory an immediate and effective safeguard to the public with regard to arsenic in beer can be secured." Of course, that contemplates that the Board of Inland Revenue should have certain punitive powers given to them for an infraction of those provisions. I do not understand how it would be possible in a court of law to secure convictions unless the warranties and guarantees were given in accordance with a method laid down?—In other words, you mean that it must be invoiced or guaranteed to pass certain tests, just as in commercial matters benzol is sold as being 90 per cent. benzol according to a specified test?

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12074. Yes?—That implies that if you are going to guarantee it, you must prescribe the method of testing—I think that almost follows—or a method giving concordant results.

Guarantees should have reference to prescribed tests or methods

12075. There you introduce a difficulty, and you will see at once the difficulty that is introduced—namely, that you may have a conflict of evidence. The analyst, for example, may be able to bring rebutting evidence that a thing is below the standard which is prescribed, whatever that standard may be. You see that introduces a difficulty in giving effective power to the Board of Inland Revenue in the case of infractions of the warranty?—Take the matter personally. I can conceive that I might individually be clever enough to invent some process which in my hands gave me accurate and superior results to the prescribed method; I should be perfectly justified in using that method for my own purposes, but if I should be thinking of condemning a sample, I should say, "Well, it must show that result by the official test, and, therefore, I should be bound by the official test in reporting; but for my own convenience I might use another one which I had found to give comparable results." I do not like to be tied down only to use a certain method when a better might be invented; but, certainly, if you are going to specify it, it must be on the basis of an official test in the same manner that we at present say that milk must contain 8·5 per cent. of non-fatty solids and 3 per cent. of fat, although the time may come when those really will not be the best criteria of genuine milk.

12076. That is not quite the point, is it? In this particular case, inasmuch as we are dealing with very minimal quantities of material, the particular way in which those have been arrived at is all-important?—Very important as an arbitrary test.

12077. Your statement perhaps is subject to the qualification you now make?—Yes, I think that is so.

Dr. John Augustus Voelcker, called; and Examined.

Dr. J. A. Voelcker.

12078. (*Chairman.*) I believe you have devoted yourself very much to the application of chemistry to agriculture?—I have.

Taking up of arsenic by farm crops. Experiments at Woburn.

12079. You are able to give us evidence, that I am sure we shall find very interesting, regarding the taking up of arsenic by farm crops?—Yes.

12080. You have made experiments at the Woburn experimental station of the Royal Agricultural Society of England, I believe?—I have.

12081. Were those experiments made in the year 1901?—Yes.

12082. Were those experiments made for the purpose of inquiring into arsenic in connection with this Commission?—They were not originally instituted in connection with the inquiry of this Commission. As the question of the contamination of food products with arsenic was raised, I thought it desirable to institute experiments on the question with regard to farm crops, principally because of the assertion that had been made in some quarters as to farm crops, and particularly barley, being contaminated with arsenic through the use of artificial manures. It was with that object that I instituted the experiments at the Royal Agricultural Society's farm.

12083. Had you previously had occasion to consider the question of possible danger to food in consequence of arsenic having been contained in the manure or in the soil?—I had previously for a number of years often been called upon, for instance, to test different commercial samples of superphosphate for the possible presence of arsenic, and I also had at intervals submitted to me roots and grain which had been grown with superphosphate, for the purpose of ascertaining whether they contained any appreciable quantity of arsenic.

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12084. Was that before this Commission came into existence?—It was before this Commission opened.

12085. You were alive then to the importance of the question?—I was alive to the importance of the question, and to the possibility of arsenic being introduced in that way, but, having no definite experiments that I could rely upon, I thought it advisable that a society, such as the Royal Agricultural Society, might very well carry out trials with respect to this.

Soil.

12086. I understand that those experiments conducted in 1901 were conducted with crops grown on a sandy loam?—The soil of Woburn happens to be a sandy loam; at the same time the farm comprises three different kinds of soil varying somewhat in respect of heaviness. One field is a very light soil; another one, which is mentioned in my epitome as being Warren Field, is a distinctly heavy soil; and a third one is intermediate.

12087. How do you distinguish a heavy soil from a light soil?—As a matter of fact, the geological formation alters exactly at our farm. We have one portion of the farm on the Lower Greensand, and another portion on the Oxford clay. The one field that I have called here Lansome Field is on the Lower Greensand. The Lansome Field is the light soil, and the Warren Field is the heavy soil.

Crops.

12088. On the Lansome Field, with a crop reared in the ordinary way, you examined eight plots, a quarter of an acre each, I think, and we have the results of these and your other experiments in this epitome?—Yes.

EPITOME of EXPERIMENTS conducted at the Woburn Experimental Station of the Royal Agricultural Society of England in 1901.

Soil.—A sandy soil.
Crops.—Barley, Swedes, Mangels.
Pot-culture experiments on Barley.
Analyses made by Mr. Otto Hehner.

I. Barley.—Lansome Field. Crops reaped in ordinary way. Eight plots, one quarter acre each, treated as follows :—

——	Manures per Acre.	Arsenic in Crop.	
		Grain.	Straw.
			Grains per lb.
Plot 1	Without manure	None.	·006
Plot 2	3 cwt. Superphosphate made with arsenic—free acid	,,	·007
Plot 3	3 cwt. Superphosphate containing ·01 per cent. arsenic	,,	·006
Plot 4	3 cwt. Superphosphate containing ·03 per cent. arsenic	,,	·004
Plot 5 (duplicate of 4.)	3 cwt. Superphosphate containing ·03 per cent. arsenic	,,	·004
Plot 6 (duplicate of 3.)	3 cwt. Superphosphate containing ·01 per cent. arsenic	,,	·005
Plot 7	5 cwt. Superphosphate containing ·01 per cent. arsenic	,,	·004
Plot 8	5 cwt. Superphosphate containing ·03 per cent. arsenic	,,	·004

II. Pot-culture experiment on Barley.—The straw being cut off when crop was ripe, and not allowed to lie on soil (as in the field).

——	Arsenic in Barley Straw.
	Grains per lb.
Barley manured at rate of 3 cwt. per acre of superphosphate containing ·50 per cent. arsenic	·007

III. Swedes.—Road Piece Field. Crop gathered in ordinary way ; leaves left lying on ground ; bulbs topped and tailed, and stored in heaps on land ; bulbs cleaned and washed before analysed ; leaves not washed.

Six plots (each duplicated) manured as follows :—

——	Manures per Acre.	Arsenic in Crop.	
		Bulbs.	Leaves.
			Grains per lb. in dried leaves.
Plot 1	Without manure	None.	—
Plot 2	3 cwt. Superphosphate made with arsenic—free acid	,,	—
Plot 3	3 cwt. Superphosphate containing ·01 per cent. arsenic	,,	·02
Plot 4	5 cwt. Superphosphate containing ·01 per cent. arsenic	,,	—
Plot 5	3 cwt. Superphosphate containing ·03 per cent. arsenic	,,	—
Plot 6	5 cwt. Superphosphate containing ·03 per cent. arsenic	,,	

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IV. Leaves of Swedes and Mangels, after cleaning and washing (to remove attaching soil, &c.). Crops under ordinary cultivation.

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	Swede Leaves.		Mangel Leaves.
	Warren Field.	Great Hill.	Warren Field.
Arsenic.—Grains per lb. of dried leaves - - - -	·004	·002	·002

V. Soil.—Tested for arsenic (in air-dried soil).

	Warren Field.	Great Hill.
Arsenic.—Grains per lb. - - - - - -	·02	·014

Results.

Barley.

12089. What were the results of treating the plots in different ways?—In Plot No. 1, without manure there was no arsenic in the grain; in the straw there were 0·006 grain per lb. In Plot No. 2, which was manured with 3cwt. per acre of superphosphate made with arsenic-free acid, there was no arsenic in the grain, but there was 0·007 grains per lb. in the straw. In Plot No. 3, manured with 3cwt. of superphosphate containing 0·01 per cent. of arsenic, there was no arsenic in the grain, but 0·006 grains per lb. in the straw. In Plot No. 4, manured with 3cwt. of superphosphate containing 0·05 per cent. of arsenic, there was no arsenic in the grain, but 0·004 grains per lb. in the straw. In Plot No. 5 (duplicate of No. 4), manured with 3cwt. of superphosphate containing 0·05 per cent. of arsenic, there was no arsenic in the grain, but 0·004 grains per lb. in the straw. In Plot No. 6 (duplicate of No. 3), manured with 3cwt. of superphosphate containing 0·01 per cent. of arsenic, there was no arsenic in the grain, but 0·005 grains per lb. in the straw. In Plot No. 7, manured with 5cwt. of superphosphate containing 0·01 per cent. of arsenic, there was no arsenic in the grain, but 0·004 grains per lb. in the straw. In Plot No. 8, manured with 5cwt. of superphosphate, containing 0·05 per cent. of arsenic, there was no arsenic in the grain, but 0·004 grains per lb. in the straw. The practical result of that is that when barley was grown upon this soil and treated in different ways with superphosphate of the ordinary kind which the farmer would purchase, and in the quantity that he would ordinarily use, the grain being reaped and threshed in the ordinary way, it was practically free from arsenic altogether.

No arsenic in grain.

12090. The grain was practically free in every case?—Yes.

Traces in straw.

12091. But the straw showed traces?—The straw, on the contrary, showed small quantities of arsenic.

12092. I see more arsenic was shown on Plot No. 1 than on Plots 4 and 5?—The differences are not more than would be due to experimental error.

12093. Plot No. 1 was without manure, you say?—There was no added superphosphate in Plot No. 1, but there was as much as 5 cwt. per acre used in Nos. 7 and 8.

Quantities of superphosphate used; percentage of arsenic; and controls.

12094. I see you had either 3 cwt. or 5 cwt. of superphosphates?—I took those two quantities because they would very well indicate respectively a moderate and an extreme quantity of superphosphate that a farmer would use for the cultivation of barley; 3cwt. per acre is an ordinary quantity; it is the quantity that we should use ourselves on this very land, and to grow this particular crop. Five cwt. is an extreme quantity; it may be used in some parts of the country, but it is very seldom that that quantity would be exceeded. Similarly, with regard to the quantity of arsenic contained in the manures used, the figures are taken from determinations of arsenic that I have made in a number of commercial samples that have been sent to me for the last ten years or so for the purpose of testing the amount of arsenic present in them. I desired in this case to take, first of all, the natural land without any superphosphate—that is, Plot No. 1. In the second case I took the ordinary dressing of superphosphate, but it was a superphosphate made with sulphuric acid which was chemically free from arsenic. This superphosphate was made for me purposely by a chemical manufacturer; it was a small lot made for the purpose of this particular experiment. You may take the arsenic obtained here as that which has come out of the soil, subsequent analyses showing the soil of this field, as of other fields, to contain a certain quantity of arsenic.

12095. When the superphosphate was made with arsenic-free acid, may we assume that the superphosphate so made was free from arsenic?—I do not think that it is quite fair to assume that. I doubt myself whether it is possible in any factory to make a superphosphate free from arsenic and to keep it free from arsenic. I should believe that the very presence of the atmosphere in the manufactory and the dust flying about will be enough to cause a perceptible amount of arsenic to be found even in the superphosphate that had been made originally with pure acid. In fact, I subsequently tested this very sample, and I could not say it was perfectly free from arsenic.

12096. You tested the superphosphate and found traces of arsenic in it, do you say?—Yes.

12097. Though it was made with acid free from arsenic?—Quite so.

12098. Then there can be no doubt that in Plot No. 8 there was much more arsenic in the soil than there was in Plot No. 1; it was the same soil which in the first place was without manure and in the second had 5 cwt. of superphosphate containing 0·05 per cent. of arsenic?—There would be from five to six times as much as in No. 1.

12099. And yet there is less arsenic in the straw?—Yet there is less in the straw; but the whole of these figures are within experimental error.

12100. The whole amount in the straw is so small that you do not consider these results inconsistent with the data as to manure; they simply show that in every case the arsenic was very small?—Yes.

12101. It is rather remarkable that the more arsenic there is in the manure, the less there is in the straw—one of your results brings that out, of course, on the very small figures?—It shows that with an increase of arsenic in the superphosphate you do not necessarily get an increase in the arsenic taken out. A subsequent experiment shows that in very great measure the amount of arsenic recorded in the figures which I have given is really an accidental mechanical admixture.

Much of the arsenic due to adherent soil, &c.

12102. Due to the dust and soil upon the straw?—Quite so. It is to that rather than to any actual differences in regard to absorption that I attribute the figures here given.

12103. Then to what do you attribute the arsenic in the straw in the case of Plot No. 1, for example, which was without any manure at all; there must be some arsenic in the soil?—There is arsenic in the soil, and I

confirmed that by analysis of the soil. You will find the analysis given under heading V., in my epitome.

12104. That may have been the result of manuring with superphosphate in previous years?—It may have been that, but personally I believe that you will not get any soil in which you do not find about that amount of arsenic—any soil, for instance, that contains pyrites is pretty sure to contain arsenic.

12105. Have you examined many soils independently of this farm for arsenic?—No, I have not, because the question had not arisen before; but I have done so lately, and I have never been able to find one that did not give some signs of arsenic.

12106. Is there any arsenic in coprolites, for instance?—There is pretty sure to be arsenic there.

12107. They are largely used for manure, I believe?—Not now; they were formerly, but the coprolite industry is quite worked out now in this country.

12108. Why has it been given up?—The coprolites are not rich enough, and it does not pay. The principal sources of the raw materials of superphosphate manufacture are the Florida phosphates and the Algerian phosphates, and others, which are very much richer than coprolites; coprolites would only contain from 48 to 60 per cent. of phosphate of lime, whereas these other phosphates will contain something like 80 per cent. The difference of working cost has so much altered that it makes it unprofitable to work the coprolite beds any more. It is in these coprolite beds, and where you have iron associated with the coprolites, that you would expect to find the iron pyrites, and consequently a considerable amount of arsenic.

12109. What is the chief object of these manures; is it to introduce phosphorous?—Yes.

12110. And nothing else?—Nothing else. The superphosphate is simply to be regarded as a means of giving phosphate to the crops.

12111. So far as your experiments go there is very little absorption from the soil into the grain?—Very little. I am not able at the present time to discriminate entirely between what may be mechanically attaching and what may pass into the tissues of the plant; but I am prepared so far to say that in the firm parts and the matured parts of the plant, such as the grain, the arsenic is not taken up, whereas in the greener parts, such as the leaves and the stalk, it is quite possible that there may be a certain amount. I am fully of opinion that where results have been recorded as giving in straw or leaves a certain amount of arsenic, to a great extent, this is due to the mechanical attraction of particles of soil or manure which contain arsenic.

12112. The outside of the leaves being soiled with the soil—dirtied with the soil?—Quite so. For instance, a barley crop in a field will be cut off close to the ground, but the whole straw will be splashed up with bits of the soil when the rain comes, and bits of manure may subsequently be thrown up. Also in the ordinary processes of threshing and cleaning the grain, there is a great deal of dust flying about which may contain small quantities of arsenic. It is quite reasonable to suppose that the softer parts of the plants, such as the leaves and the straw, will more easily take it up mechanically than will the hard grain.

12113. Would it be a merely surface layer which could be washed off the leaves, or do you think it gets in at the surface, and is soaked into the leaves?—I am not prepared to say that in the case of the straw and the green parts of the plant it is entirely a surface attraction; but I am prepared to say that if you take a crop of barley, for instance, with its straw, and reap it in the ordinary way, and lay it on the soil, you will have a good deal more arsenic than if you grow it under conditions where it does not lie on the soil and is not subject to the mechanical additions that it would get in that way.

12114. Then I understand you made experiments on the pot culture of barley; the straw being cut off when the barley was ripe, and not allowed to lie on the soil (as in the field)?—Those experiments were carried out as being supplementary to the field experiments. Our object at Woburn is to carry on scientific experiments side by side with practical ones, and in a question like this, when I was considering the absorption of arsenic by plants, I thought it was very desirable in the first place to carry out experiments in just the same way and on the same scale as the ordinary farmer would adopt. Therefore the figures given with regard to the field experiments are on exact practical lines. I supplemented these by carrying out other experiments on plants grown on the small scale—pot culture experiments. In one of these I grew barley with a superphosphate to which not merely the arsenic natural to the commercial acid was attached, but to which arsenic in excess, and in large excess, was added.

12115. That is Experiment II.—0·50 per cent. of arsenic?—Yes. I reaped the crop here; but you would not in such a case get the same amount of mechanical attraction from the soil that you would in the fields, because the straw when reaped was taken straight away. You will find that although the quantity of arsenic supplied was 50 times as much as in the case of plot 3, yet the amount of arsenic in the straw was not much more than in the case of plot 3.

12116. Just the same as in the case of the superphosphate made with arsenic-free acid and used on plot No. 2?—Yes, just the same.

12117. Is that not a very large amount of arsenic to be in a superphospate?—That is an altogether extreme quantity. Such an amount would never come forward in practice.

Effect of arsenic on vitality of plant.

12118. Have you any evidence as to whether that interfered with the health of the plant?—I have some very clear evidence about that, which I will be happy to lay before you. These results are not given in the summary, but since preparing the latter, I have been able to put my notes together with regard to this further point. I had no less than 11 different sets of pot-culture experiments, where the soil of one of these ordinary fields was used, and where I treated the barley plant in different ways. In the first case I used no superphosphate at all. In the second case I used 3 cwt. per acre of superphosphate free from arsenic. In the third case 3 cwt. of superphosphate with 0·01 per cent. of arsenic, and so on, with varying quantities up to 3 cwt. per acre of superphosphate containing ·05 per cent. of arsenic, which figure, according to my experience, is the highest that one meets with ordinarily in commerce. After that I added arsenic in excess directly as arsenious oxide, and the next series contained 3 cwt. of arsenic-free superphosphate per acre., to which I added 0·15 per cent. of arsenic as arsenious acid. In the next series there was 3 cwt. of superphosphate, with ·30 per cent. of added arsenic, and in the next 3 cwt. of superphosphate, with ·50 per cent. of added arsenic. The remaining series consisted of soaking the seed directly in solutions of arsenic. I used arsenious acid, and dissolved it with a weak caustic soda solution so as to get it into solution. Having done that, the soda solution was almost neutralised with acid, remaining slightly alkaline; and that was added to the ordinary superphosphate. I had different sets containing the following amounts:—Seeds soaked for 30 minutes in ·15 grammes of arsenic in 100 cubic centimetres of water; that is, ·15 per cent. In the next set the seeds were soaked for 30 minutes in ·30 per cent. In the next the seeds were soaked for 30 minutes in ·50 per cent; and in the last the seeds were soaked for 30 minutes in a 1·0 per cent. solution. I kept observation on those different lots, and it was only with the last lot—the seed when it was soaked in a 1 per cent. solution of arsenic—that germination was at all affected. I have here a record of the dates at which the different plants appeared, and so far as the germination of the seed was concerned there was practically no effect until you got above a strength of half per cent. of arsenic used in a solution.

12119. So the weaker solutions applied for the length of time you mention did not exercise any perceptible effect?—The weaker solutions had no effect in preventing or in retarding the germination.

Experiments with swedes.

12120. Then I understand you experimented on swedes?—Yes. The reason of my taking that crop was that it has often been asserted that a crop such as swedes might do harm eventually to people, because the swedes might be eaten off by sheep, the sheep might return the arsenic to the land in their droppings, and as it is a common practice, especially in our part of the country, to grow barley after swedes, so the arsenic might be carried on perhaps into the people who ate the mutton, or into the barley which was grown subsequent to the roots. Therefore I thought it well to experiment with the swede crop also. Very much the same series of practical experiments was carried out as with barley, viz., on quarter-acre plots of land. Plot 1 was without manure; on plot 2 there was 3 cwt. per acre of superphosphate made with arsenic-free acid;

experiments 7 and 8. I should think that in Mr. Angell's experiments a good deal was due to the fact that he did not destroy the organic matter.

12159. (*Chairman.*) That, you think, may have made a difference in his estimations?—Yes, I think it affected the estimations.

Only two specimens of soil tested for arsenic.

12160. In reference to the soils which you tested for arsenic, did you test a large number of the specimens of Warren Field and of the Great Hill Field?—No; there were not a large number.

12161. I see there is just one result given in each case, namely, ·02 of arsenic in grains per lb. for Warren Field, and ·014 for Great Hill?—I was saying just now that there are very few determinations made by modern and exact methods of the amount of arsenic in soils.

12162. Those two are a small number of tests?—That is all.

12163. Just two individual tests, were they?—Two individual tests. I made these because of finding arsenic in the leaves. I should not have thought of the arsenic being in the soil had it not been for the quantity found on the leaves.

Dr. J. A. Voelcker.

3 April 1903.

APPENDICES.

(Nos. 16 to 32.)

For detailed list of subjects of Appendices in this Volume, see Table of Contents, pages vi–viii.

APPENDIX 16.

PROF. DELÉPINE'S RAT EXPERIMENTS.

EXPERIMENTAL INVESTIGATION UPON THE ACTION OF ARSENICAL BEER AND OTHER ARSENICAL SOLUTIONS ADMINISTERED IN LARGE QUANTITIES TO RATS.

Handed in by Professor S. Delépine, 13 June 1902.

The objects of this investigation were to ascertain:—

1. Whether the presence of arsenious acid in beer could account for the changes observed in persons who had consumed arsenical beer.

2. Whether it was necessary to assume that a compound more poisonous than arsenious acid was present in arsenical beer.

3. Whether the presence of organic compounds of arsenic such as cacodylates could account better for the effects of arsenical beer than the presence of arsenious acid.

4. Whether the quantities of arsenic found in beer by chemical analysis were sufficient to account for the effects produced by arsenical beer.

5. Whether the presence of alcohol in such amounts as are usually present in beer so favour the pathogenic action of arsenic as to render minute doses of that poison exceptionally noxious.

6. Whether concurrent influences, such as insufficient diet, could account (as I had surmised) for the different effects of arsenical beer upon different individuals.

Rats were specially suitable for the experiments, because they take beer and weak watery solutions of alcohol and arsenious acid very readily, and can adapt themselves to considerable variations in their diet.

They are less affected by arsenic than man and many other mammals.

In man doses of arsenious acid varying between 0·1 gramme and 2 grammes have been stated to produce death (Lachèse, Tardieu, Orfila).

A dose of 2 grammes to a man of moderate weight *i.e.*, weighing about 63,000 grammes, is equivalent to a dose of 0·003 grammes per 100 grammes body weight. Rouyer has found that arsenious acid or arsenites administered to dogs by the mouth was fatal in doses of 0·006 grammes per 100 grammes body weight (a dose of 0·015 grammes of arsenate of soda is necessary to produce the same result). Such a dose usually produces death in twenty-four or forty-eight hours. In rats I have found that a much larger dose was necessary to produce death in four and five days when administered by the mouth. A single dose of 0·012 per cent. of body weight produced the death of a rat weighing 135 grammes in four days. Two doses each of 0·006 grammes per cent. of body weight administered to another rat weighing 141 grammes produced death in five days from the giving of the first dose. From these results it would appear that the lethal dose of arsenious acid administered by the mouth may be for rats at least twice greater than the lethal dose for dogs, and four times greater than the lethal dose for man. (*See* General Table (I.) of Results, Experiments 16 and 17.) These figures are necessarily only approximate, especially with regard to man, but they are none the less useful in forming an opinion upon the value of the results obtained in experiments on rats. Thus, in trying to estimate the probable effects of certain quantities of arsenical beer upon man, I have thought it desirable to administer to a certain number of rats solutions containing at least four times more arsenic than I had found in the most contaminated beers examined by me during the outbreak. I have, however, also used doses smaller than those actually taken by many beer drinkers.

Most of the beers I have examined contained less than 2 grains of arsenic per gallon. In one case I have found over 1½ grains of arsenic per gallon. The largest quantity of arsenious acid I gave to rats for ordinary experimental purposes was 7 grains per gallon, the fluid being given at the rate of 1 gallon a day for a man weighing 140lbs. The quantity of beer taken by sufferers has frequently exceeded 1 and 2 gallons daily, *i.e.*, 7·14 per cent. to 14·28 per cent. of the weight of a man weighing 140lbs. I have administered the arsenical beer or solutions in quantities equivalent to 8 per cent. or 16 per cent. of the body weight of the experimental animals. The slight excess being allowed as a compensation for accidental unnoticed losses.

Condition of the experiments.

The experiments were conducted in sets. In each set a certain number of rats were placed under conditions absolutely identical. All the cages were of the same size and shape, placed side by side in the same part of the room, so as to be at the same temperature and receive the same amount of light. All the rats were fed at the same hour in the morning, and were weighed just before being fed. A certain number of experiments were always carried out simultaneously, these groups of experiments constituting what I call a set. The various sets were started at short intervals from each other, but care was taken to make the general conditions in the various sets as similar as possible.

Mode of feeding. Comparable periods.

To test the action of the arsenic and alcohol it was necessary to submit the animals to variations in the feeding. (The victims of the arsenic epidemic belonged chiefly to a class liable to great irregularities in their diet.) During certain periods of each set of experiments these variations were identical for the various animals composing the set. It is upon those "comparable periods" that conclusions must be chiefly based. The comparable periods in all cases extended over one month, and in several sets over seven or eight weeks.

Analysis of results.

In considering the results of each set of experiments, it will be necessary to analyse the results obtained, first, during the whole time the animal was under observation (*see* Diagrams and Table I.); second, during each special period characterised by the administration of a special amount of food (*see* Diagrams); third, during the comparable groups of periods (Diagrams and Table II.). To make all the results comparable all the quantities have been reduced to a percentage of the weight of the animal at the beginning of each experiment and at the beginning of each special group of periods composing the comparable periods.

Estimation of the amount of food and drink taken by the experimental rats.

Definite quantities of food and drink were daily measured and weighed, but it sometimes happened that the rats did not take the whole supply. When any food or fluid was left over at the end of twenty-four hours this was carefully weighed before a new supply of food was given. I have, therefore, distinguished in the record of results between the amount of food and drink given and those taken. All the figures recorded have been calculated on the basis of the food and drink actually taken. In the diagrams the amounts given are indicated as well as the amounts left over (except when the difference was trifling). The amounts left over were generally indications of a bad state of health or of a dislike for certain solutions (watery solutions were usually not so well taken as beer).

The description of each set of experiments will indicate the special object of that experiment.*

* In Table I. a synoptical summary of quantities given during the whole course of the experiments and of the gross results will be found. In Table II. a similar summary relating to comparable groups of periods. In the diagrams 1 to 6 detailed records of daily variation will be found. In these tables and diagrams the same numbers and letters of reference as those given in the text have been used. Although daily records have been kept in all the experiments, I have found it advisable to record in the diagrams the average results of consecutive periods of three days. In this way the curves have been equalised and the irregularities produced by micturition and defæcation reduced to a minimum. For shortness sake the word arsenic is frequently used here as synonymous with arsenious acid. The word arsenicum is used to designate metallic arsenic.

Appendix 16.

A. ALTERATIONS OBSERVED DURING THE LIFE OF ANIMALS EXPERIMENTED UPON.

First set of experiments.

First Set of Experiments.—This consisted of five experiments, one of which had to be discarded at the end of one month. A pregnancy of the animal, which had not been noticed at the onset, caused alterations in weight which vitiated the results. The four other rats were given respectively:—

Experiment 1.—Salford arsenical beer containing 25 parts of arsenic per 10 million parts, or about ¼ grain per gallon. The amount given daily was about 16 per cent. of the body weight (corresponding to over 2 gallons for a man weighing 140lbs.), amount of alcohol about 5 per cent.

Experiment 2.—Watery solution of arsenious acid containing 20 parts of As_2O_3 per 10 million (or about 1-7th grain per gallon). Amount given daily, 8 per cent. of body weight (corresponding to over 1 gallon for a man weighing 140lbs.). No alcohol.

Experiment 3.—Salford arsenical beer to which arsenious acid was added so as to make the total amount of arsenic equal to 1,000 parts per 10 million, or about 7 grains per gallon. Amount given daily, 8 per cent. of body weight (corresponding to over 1 gallon for a man weighing 140lbs.); amount of alcohol, about 5 per cent.

Experiment 4.—Watery solution of arsenious acid containing 1,000 parts of As_2O_3 per 10 million (or about 7 grains per gallon); amount given daily, 8 per cent. of body weight (over 1 gallon for a man 140lbs. in weight); no alcohol.

The changes observed during the various periods of the experiment were as follows:—

Period A.—Duration, 36 days; food, oats and dry bread; amount, 14 per cent. of body weight (except in Experiment 3, in which food was 10 per cent. of body weight). In all cases but No. 4 there was a rapid increase of weight. This increase was very sudden and considerable in Experiment 3, and more gradual in Experiment 1.

Period B.—Duration, 9 days; food reduced to 3·3 per cent. of body weight (dry bread only). Great and rapid loss of weight in all cases. Rats 1 and 2, which received moderate doses of arsenic, may be compared. The loss of weight was much more marked in 2 than in 1, although rat 1 was drinking beer containing 1-6th grain of arsenic per gallon at the rate of over 2 gallons per day, and rat 2 a watery solution containing 1-7th grain of arsenic per gallon at the rate of over 1 gallon per day. The watery solution seemed therefore to be more detrimental than the arsenical beer.

In 3 and 4 the dose of arsenic was much above that found in ordinary arsenical beer. The loss of weight was not sensibly greater than in 1 and 2. Rat 4 did not usually take the whole of the watery solution given to it.

Period C.—Duration, 9 days; food increased to 5 per cent. of body weight (dry bread only). This caused a diminution in the rate of loss of weight except in 4.

This effect was most marked in rats 1 and 3, both of which were taking beer. It was more marked in rat 3 than in rat 2, although rat 3 was taking a much larger amount of arsenic than rat 2. Rats 2 and 4 did not take the whole of the watery solution given to them.

Period D.—Duration, 9 days; arsenical fluids replaced by pure water; food increased to 10 per cent. (dry bread). Considerable increase in weight of animal 1. Distinct increase, but less considerable, of animals 2 and 4. No marked effect in animal 3.

Period E.—Duration, 15 days; arsenical fluids resumed at the same rate as before Period D; food reduced to 5 per cent. (dry bread). A slight gain in weight was observed in the case of 1. All the other animals remained stationary; 2 and 4 left much of the watery solution given to them.

Period F.—Duration 12 days; experiment interrupted by the death of 2, 3, and 4); food reduced to 3·3 per cent. (dry bread). Marked loss of weight in all cases. The loss was slighter in 1 than in 2, 3, and 4. In 2 and 3 the loss was considerable. In 4 it was less marked owing probably to the animal being already considerably emaciated at the end of period E. Rat 3 died 11 days, rat 2 12 days, and rat 4 13 days after the beginning of this period. They all died suddenly, apparently from failure of the heart, or of the respiratory muscles. Rats 2 and 4 left much of the watery solution given to them.

Period G was a continuation of period F in the case of the surviving animal No. 1. This animal, kept on the same low diet for another 12 days, after a further slight loss of weight, maintained its weight for six days.

Period H.—Duration, 18 days; the arsenical beer was replaced by arsenic-free lager beer; and the food (dry bread) increased to 10 per cent. This was followed by a slight increase in weight, but after 12 days the animal began to lose flesh again. The animal, which had taken its food and drink well up to this date, began to leave a considerable portion of both untouched.

Period I.—Duration, 12 days; lager beer replaced by water; food (dry bread) remaining 10 per cent. For 6 days the rate of loss by weight remaintd the same as in the previous period, but when the weight had been reduced to about 80 per cent. of the original weight the fall ceased. Some food and drink left.

Period K.—Duration, 12 days; water replaced by lager beer; food the same as in I. No sensible effect observed. The animal took the beer better than water, but did not eat the whole of its food, although it took more food than in the two preceding periods.

The stoppage of the arsenical beer was apparently followed by a marked disorder of health, manifested by a disinclination to take food and drink, which had been well taken up to then, and a marked loss of weight. This animal was then killed.

Results during the group of periods selected for comparisons. Composed of part of period A, whole of periods B, C, D, E, and part of period F, during which the animals were submitted to the same conditions except with regard to the administration of experimental fluids.

Total duration of selected period, 60 days.

(*See* detailed account of quantities of arsenic and alcohol taken daily in Table II.)

1. Salford arsenical beer, 2 gallons daily; average daily loss of weight, 0·20 per cent.

2. Watery solution containing a little less arsenious acid than the Salford beer, 1 gallon of solution daily; quantity of arsenic taken daily less than half that taken by No. 1; average daily loss of weight, 0·62 per cent.

3. Salford arsenical beer with arsenious acid added up to 7 grains per gallon *i.e.*, containing 40 times as much arsenic as the original Salford beer); average daily loss of weight, 0·62 per cent.

4. Watery solution of arsenious acid containing 7 grains of arsenious acid per gallon (*i.e.*, the same quantity as in Experiment 3); average daily loss of weight, 0·83 per cent.

General results of first set of experiments. Provisional conclusions.

This first set of experiments seemed to indicate that—

(1) Solutions of arsenious acid in water acted in the same way as arsenical beer.

(2) That arsenical beer was less injurious than watery solutions of arsenic of the same strength.

(3) That when an animal was well fed the presence of a small quantity of arsenic did not affect its health seriously for a time.

(4) That doses of arsenic, much greater than those found in arsenical beer capable of causing symptoms of chronic arsenical poisoning, might be taken for about one month without causing death, but that death was liable to occur suddenly at the end of such a period.

(5) That after arsenical beer had been taken for a period of over three months the sudden stoppage of that fluid might be attended with disturbance of health causing serious loss of weight.

The correctness of these provisional conclusions was tested in the following set of experiments:—

Second set of experiments.

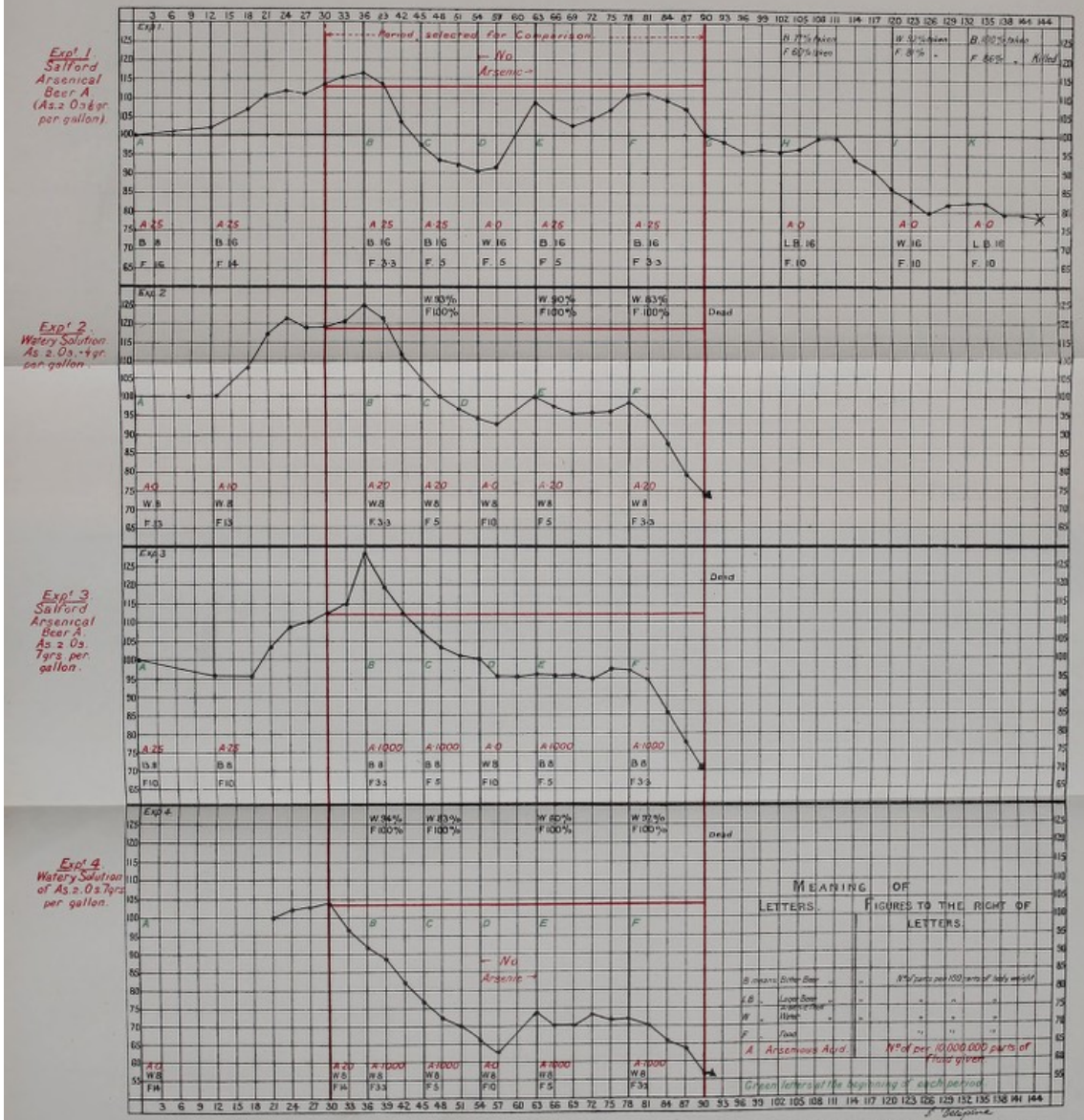
Second Set of Experiments.—Three rats were given the following fluids in daily quantities, uniformly equivalent to 8 per cent. of their body weight (corresponding to over 1 gallon for a man 140lbs. in weight).

Experiment 6.—Ordinary bitter beer, containing a trace of arsenic, always less than one part in 10 million (*i.e.*, less than 1-143rd grain per gallon); pure ethylic alcohol was added to the beer to bring the percentage of alcohol up to 10 per cent. (by weight), so as to make the beer distinctly richer in alcohol than beer in ordinary use.

Experiment 7.—Ordinary bitter beer, containing a trace of arsenic (same as that used in Experiment 6), to which arsenious acid was added so as to bring the pro-

DIAGRAM I.

SET I. *Action of Salford Arsenical Beer, of Arsenical Beer to which Arsenious Acid has been added, and of Arsenical Solutions (watery) in which Arsenic was in the same proportions as in the other fluids.*



The original weight of each animal is reduced to 100 and the subsequent weights are given in proportion to an original weight of 100 grammes.
The black Vertical lines indicate the beginning of each period of the experiment, each one of such periods is characterised by the amount of food and sometimes the kind & quantity of fluid given.
The vertical red lines indicate the beginning & the end of the group of periods selected for comparison.
The horizontal red lines indicate the weight of the animal at the beginning of the group of periods selected for comparison.
The figures in the columns on the right and left of the diagrams indicate the weights in grammes.
The figures at the top and bottom of the diagram indicate the number of days of the experiment.
The percentages given near the top line of each diagram indicate the amount of fluid and food taken when the whole of what had been given was not taken.
The figures near the bottom line of each diagram indicate the amount of fluid and food given daily.

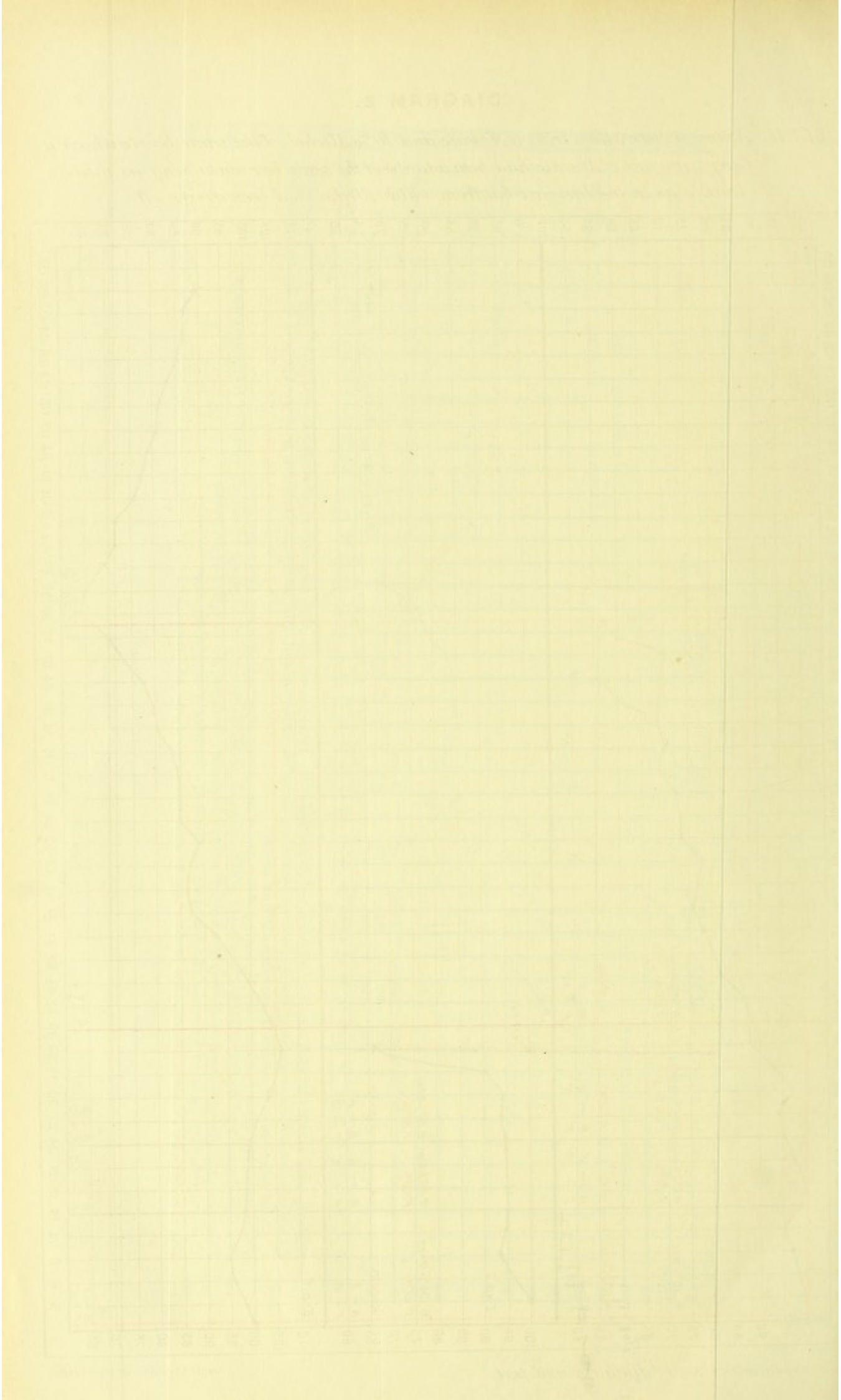
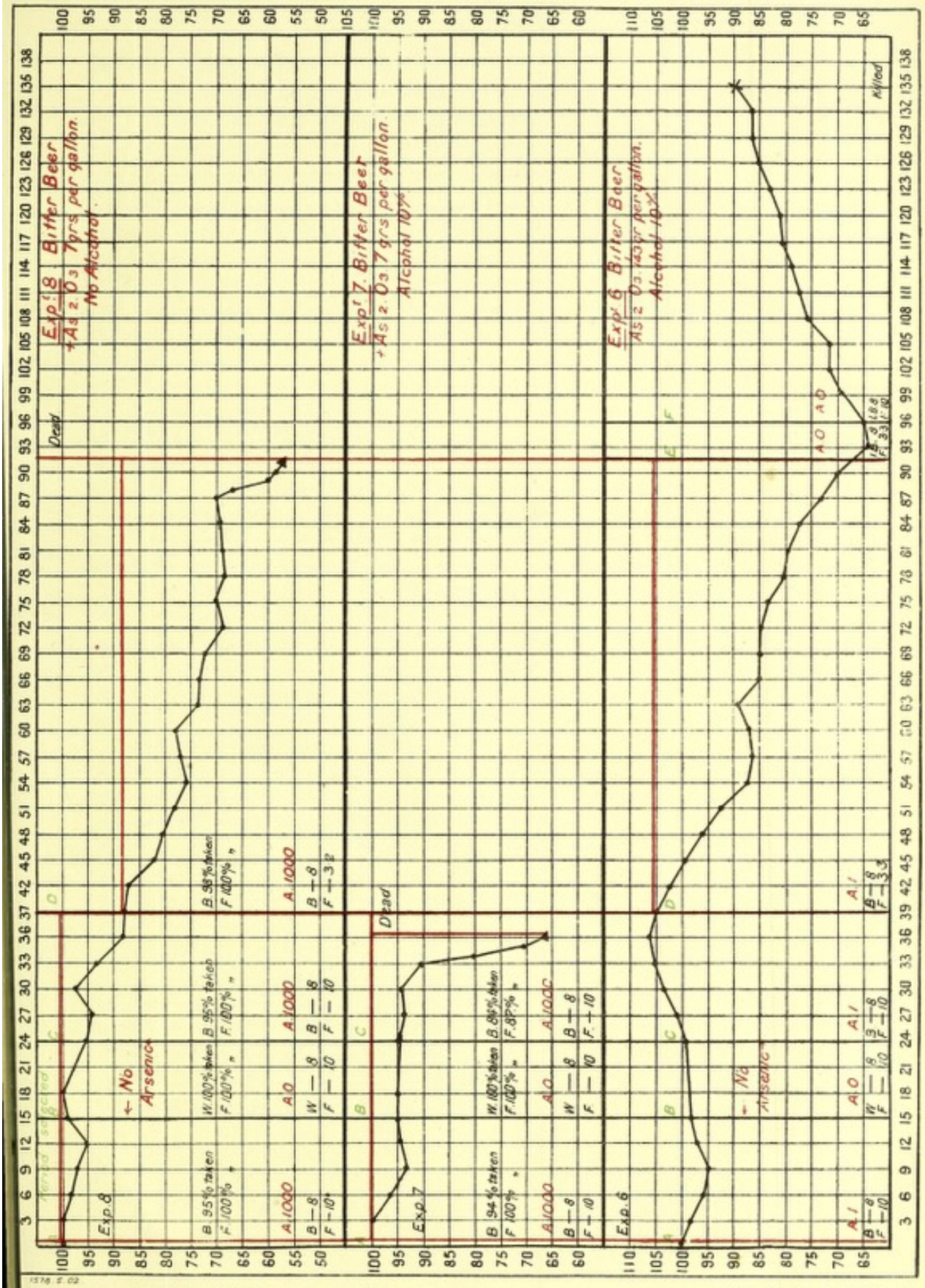


DIAGRAM 2.

SET II. *Action of Beer with a trace of Arsenic and 10% Alcohol; of the same beer to which a large amount of Arsenic had been added; & of the same beer containing as much Arsenic as in the last case but from which Alcohol had been driven off.*



For explanation see 1st diagram and text.

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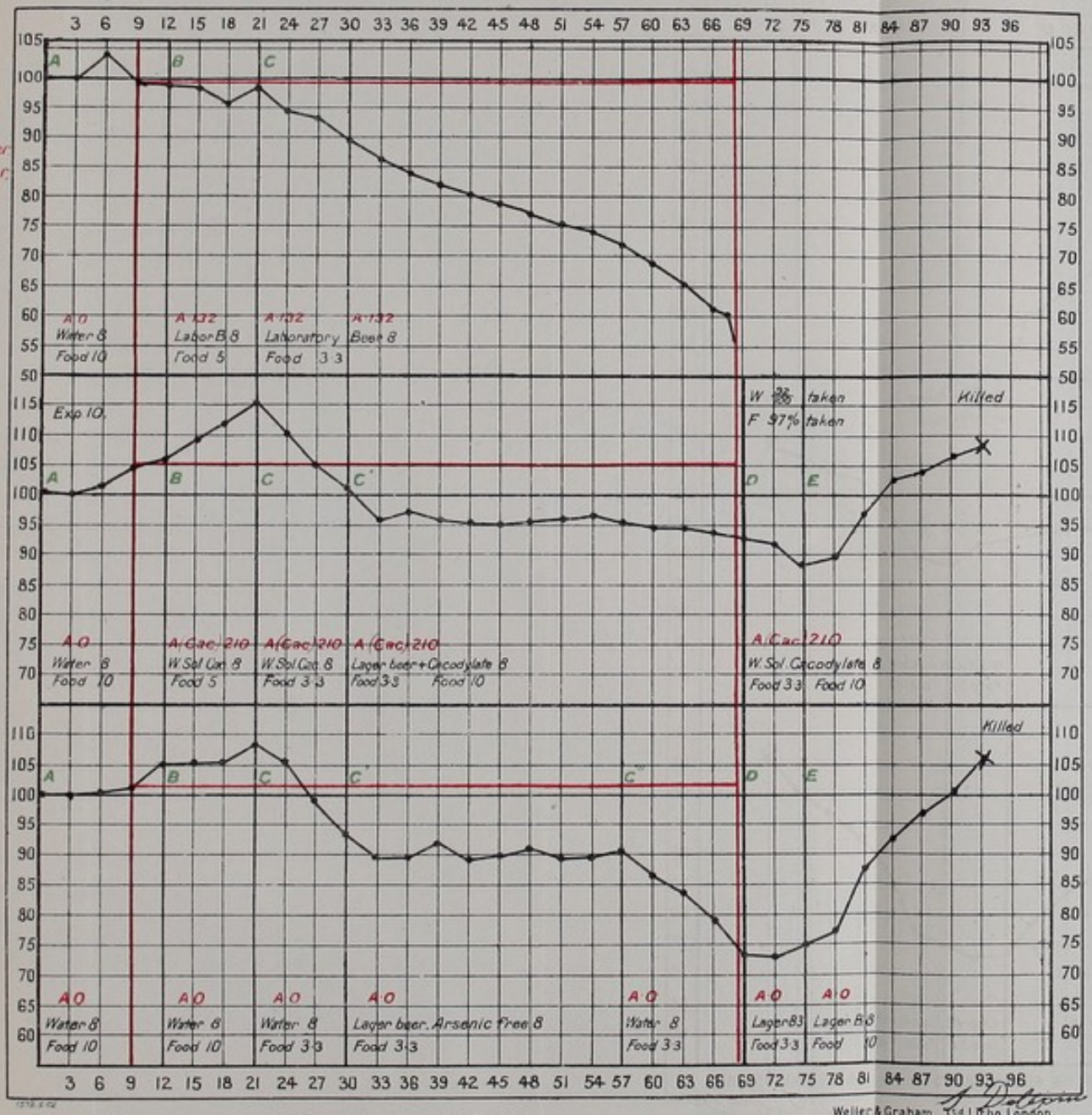
15 JUN. 1929

DIAGRAM 3.

SET III. *Action of Arsenical Beer deriving all its Arsenic from glucose; of beer or water free from Arsenious Acid and to which Kakodylate of Sodium had been added so as to bring the amount of Arsenic to the same percentage as in the first specimen; & of arsenic-free beer.*

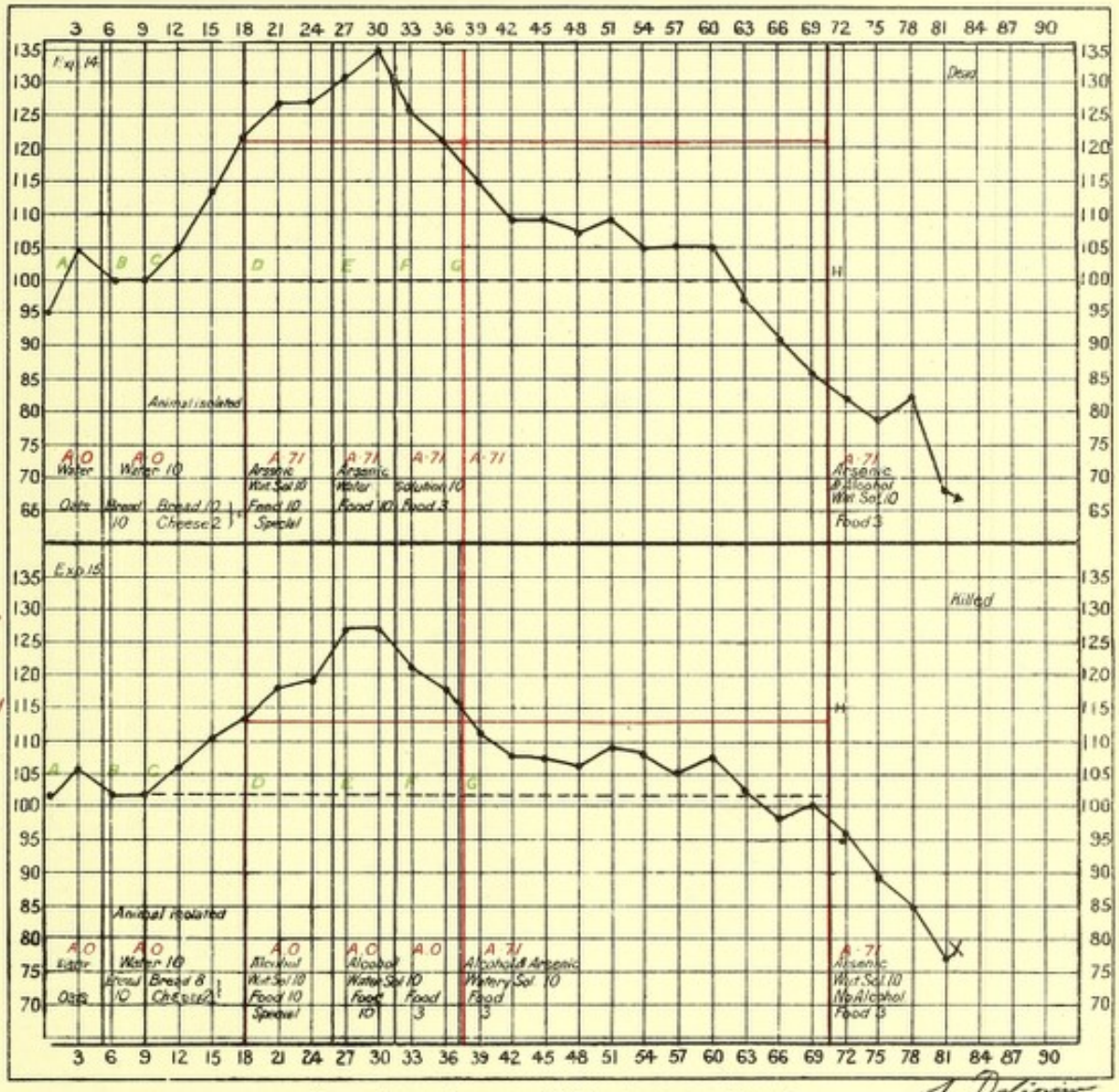


For explanations, see 1st diagram and text.

School of Hygiene
15 JUN. 1929

DIAGRAM 4.

SET IV. *Action of watery solution of Arsenic in Water and of Solutions of both Arsenic and Alcohol in Water compared.*



For explanations see 1st Diagram and text.

Up to the 18th day these experiments are control experiments, the real experiment begins on the 15th day.

J. Delépine

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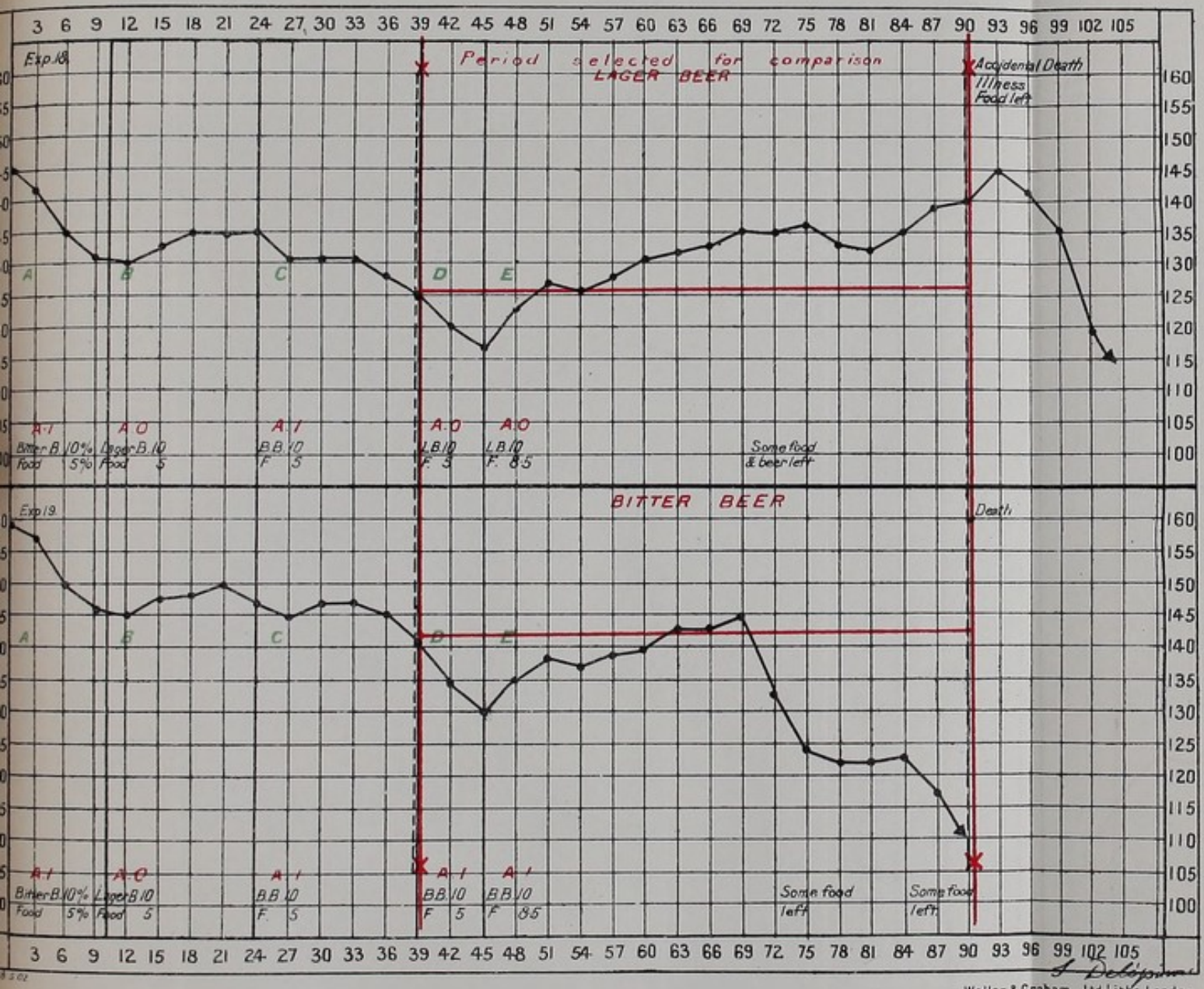
DIAGRAM 5.

VI. Action of Arsenic-free beer and of beer containing a trace of Arsenic compared.



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For explanation see 1st diagram and text.

15 JUN. 1929

portion of arsenic up to 1,000 parts in 10 million (i.e., about 7 grains per gallon); pure ethylic alcohol added so as to bring the percentage of alcohol up to 10 per cent., as in the previous case.

Experiment 8.—Ordinary bitter beer (the same as in the two previous experiments), heated in saturated steam so as to drive off the bulk of the alcohol without concentrating the beer. To this practically alcohol free beer, arsenious acid was added up to 1,000 parts in 10 millions (i.e., about 7 grains per gallon).

The changes observed during the various periods of the experiments were as follows:—

Period A.—Duration 15 days. Administration of the three beers begun at once. Food, 10 per cent. of body weight. After an initial loss of weight, rats 6 and 8 recovered entirely, in 7 a loss of weight amounting to about 4 per cent. of the original weight was observed. All the animals took their food and drink well.

Period B.—Duration 9 days. Beer replaced by an equal amount of water. Food, 10 per cent. of body weight. Slight gain in rat 6; slight loss in rat 7; marked loss (over 4 per cent.), in rat 8. The replacement of arsenical beer by arsenic free water did not seem to have a beneficial effect in any of the cases.

Period C.—Duration 15 days. Beer resumed. Food, 10 per cent. of body weight. Marked increase of weight in rat 6 (about 7 per cent.); great loss of weight in rat 7. This rat died 12 days after the beginning of the period, its weight being reduced to 67 per cent. of the original weight; marked loss of weight in rat 8. Thus, the beer containing a large amount of arsenic, plus a marked excess of alcohol, appeared to cause death sooner than the beer containing an equal amount of arsenic; but no alcohol.

Period D.—Duration 52 days. (Only 6 and 8 remain). Beer as before; food reduced to 3·3 per cent. Marked steady loss of weight in both cases. Rat 6 was reduced to 68 per cent. of its original weight; rat 8 was reduced to 57 per cent. of its original weight, and then died suddenly at the end of the period. The only animal surviving was, therefore, rat 6, which was taking beer containing a trace of arsenic and 10 per cent. of alcohol.

Period E.—Duration 5 days. To find out whether the reduction in the amount of food was alone responsible for the loss of weight the bitter beer was replaced by lager beer, the amount of food remaining the same. During the first three days the fall of weight continued, then the weight began to rise again.

Period F.—Duration 39 days. To ascertain whether the animal had been permanently injured by the low feeding and the drinking of bitter beer, with a trace of arsenic, the administration of lager beer was continued, and the amount of food raised to 10 per cent. This was followed by a steady increase in weight. The animal was killed when its weight had risen again to 90 per cent. of the original weight, and it looked again apparently quite well.

Selected comparable periods corresponding to A, B, and and C. Total duration of this period 39 days (36 in the case of rat 8). (*See* detailed account in Table II). Rat 6: Bitter beer containing a trace of arsenic and 10 per cent. of alcohol, over one gallon taken daily; average daily gain in weight, 0·11 per cent. Rat 7: Bitter beer, containing 7 grains of arsenic per gallon, and 10 per cent. of alcohol; over 1 gallon taken daily; average daily loss of weight, 0·90 per cent. Rat 8: Bitter beer, containing 7 grains of arsenic per gallon, and deprived of its alcohol, over 1 gallon taken daily; average daily loss of weight, 0·30 per cent.

The outcome of this set of experiments seems to be that arsenical beer, containing only a trace of arsenic, even in presence of an amount of alcohol above the average, is not very injurious to the health so long as a large amount of food is taken. The presence of a large amount of arsenic is clearly injurious, whether alcohol is present or not, but the presence of a large amount of alcohol seemed in this case to precipitate the fatal issue. The loss of weight in Experiment 7 was greater than in Experiment 3 (first set), in which the same amount of arsenic was administered in beer containing only 5 per cent. of alcohol. As in the first set of experiments, I observed that the replacement of the arsenical beer by pure water is not always attended with a beneficial result. The animals 7 and 8 died suddenly, in the same way as the animals of the first set died.

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Third set of experiments.

Third Set of Experiments.—This consisted of three experiments, one of which (No. 11) is a control experiment, comparable both with this and other sets of experiments. (Experiment 18 in the 6th set is another control of the same kind, and differs from 11 by the amount of food given.) Three rats were given the following fluids in daily quantities, uniformly equivalent to 8 per cent. of their body weight (corresponding to over 1 gallon for a man 140lbs. in weight).

Experiment 9.—Beer brewed in the laboratory from arsenic-free malt and hops, part of the malt being replaced by arsenical glucose obtained from Bostock's so as to introduce about 1 grain of arsenious acid per gallon of beer. At the end of the process there were found 130 parts of arsenious acid per 10 million parts of beer (or 0·91 grains per gallon), the amount of alcohol being 5·31 per cent. by weight 6.63 per cent. by volume).

Experiment 10.—Cacodylate of sodium dissolved in arsenic free beer or water, so as to make the proportion of arsenicum per gallon equal to that in Experiment 9 ($As_2O_3 = 198$)—$Na\,Kd\,O_2 = 160$). That is to say, 210 parts of cacodylate were added to each 10 million parts of fluid, giving a quantity about 1·47 grain per gallon).

Experiment 11.—Water or arsenic free beer (lager beer). The changes observed during the various periods were as follows:—

Period A.—Duration, 12 days; food, 10 per cent. of body weight; water, 8 per cent. of body weight. Slight loss of weight in rat 9. Distinct, but moderate, increase of weight in rats 10 and 11.

Period B.—Duration, 9 days; administration of experimental fluids mentioned above, quantity 8 per cent. of body weight; food, 8 per cent. of body weight. Rat 9, slight loss of weight. Rat 10, considerable increase of weight. Rat 11, slight increase of weight.

Period C.—Duration, 48 days; experimental fluid given in the same quantities as in the previous period; food, reduced to 3·3 per cent. of body weight. Rat 9, steady and considerable loss of weight, amounting to 45 per cent. of original weight. The animal died suddenly at the end of the period. Rat 10 (nine days after the beginning of this period, the cacodylate of sodium which had previously been given dissolved in water, was given dissolved in lager beer, to make experiment 10 comparable with experiment 9). So long as the watery solution was given there was a rapid loss of weight, but as this followed a previous rapid increase, the weight of the animal did not fall below the original weight.

(C 1.) Soon after the water had been replaced by beer the loss of weight ceased to be manifest, and at the end of the period (although the diet had been insufficient) the loss was only about 7 per cent. of the original weight. Rat 11: This animal was given water for the first 9 days, to allow comparison to be made between experiments 10 and 11. As in 11, a considerable loss of weight was observed.

Arsenic free lager beer was then given instead of water, and as in the previous case, this prevented a further loss of weight.

(C 2.) To ascertain whether the beneficial action was really due to the administration of beer 25 days later the lager beer was again replaced by water; this was followed by a rapid loss of weight.

The results obtained during this period seem to show:—

Summary of results obtained during period C. of third set of experiments.

1st. That the arsenical beer brewed in the laboratory and deriving its arsenic from arsenical glucose, and containing no more arsenic than beer found on the market during the epidemic, was very noxious.

2nd. That solutions of cacodylate of sodium in water and in beer, behaved much in the same way as water and beer free from arsenic. The presence of cacodylate of sodium seemed even to have a beneficial effect.

3rd. That an animal receiving an insufficient diet kept its weight better when given arsenic free beer than when given water to drink. The beer in such cases apparently acted as food.

Period D.—Duration, 6 days; food, the same as during the previous period (3·3 per cent.). Rat 10: Lager beer solutions of cacodylate of sodium replaced by watery solutions of the same strength. Loss of weight equal to about 4 per cent. of original weight. Rat 11: Water replaced by lager beer. Gain of weight about 2 per cent.

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of original weight. These results confirm those observed during period C as regard the action of cacodylate of sodium and of arsenic free beer.

Period E.—Duration, 19 days; food increased to 10 per cent; fluids continued as in period D. Rat 10: Rapid increase in weight; at the end of this period the weight of the animal was 108 per cent, of the original weight. The rat was then killed. Rat 11: Very rapid increase in weight. At the end of the period the weight of the animal was about 106 per cent. of its original weight. It was then killed.

These results show that after being on an insufficient diet for 54 days, and losing weight, an animal taking a large quantity of cacodylate of sodium, recovered its weight as well as an animal having received no arsenical fluid, when put on an abundant diet.

Selected comparable groups of periods, corresponding to A, B, and C. Total duration, 60 days; food insufficient during greater part of period.

Experiment 9.—Laboratory beer, containing 0·91 grain of arsenious acid per gallon, arsenic derived from arsenical glucose. Average dose taken over 1 gallon per diem. Daily loss of weight, 0·76 per cent. of original weight.

Experiment 10.—Cacodylate of sodium dissolved in water or beer, 1·47 grains per gallon, average dose taken over 1 gallon per diem. Daily loss of weight, 0·22 per cent. of original weight.

Experiment 11.—Water or arsenic-free beer, average dose taken daily, over 1 gallon. Daily loss of weight, 0·45 per cent.

General results of third set of experiments. Provisional conclusions.

This set of experiments showed that beer containing arsenic derived from arsenical glucose, used as a malt substitute in brewing, was apparently as injurious as finished beer to which pure arsenious acid had been added. Cacodylate of sodium had apparently no bad effect, and seemed even to be beneficial. Beer free from arsenic, and containing a small amount of alcohol, was distinctly beneficial, and apparently acted as a food.

Fourth set of experiments.

Fourth set of experiments.—This consisted of experiments on 2 rats which were kept under observation for over two months. These experiments had for object to compare the effects of watery solutions of pure ethylic alcohol, and of watery solutions of pure arsenious acid, in which the alcohol and arsenic were present in quantities similar to those found in arsenical beer. Opportunity was also taken to observe the effects of isolation of the animals, and of the addition of some animal food to the vegetable diet given in the course of all the other experiments.

Period A (Experiments 14 and 15).—Duration, 6 days. Both animals were left for 6 days among other rats supplied with an unlimited amount of oats and water. Both rats exhibited considerable daily variations of weight, but at the end of the period had not gained more than most of the isolated rats supplied with 8 or 10 per cent. of their weight of food.

Period B.—The two rats were then isolated, and the amount of food reduced to 10 per cent.; the weight remained stationary for three days.

Period C.—A part of the bread was then replaced by an equal amount of cheese (bread 8 per cent., cheese 2 per cent. of the body weight). At the end of 9 days both animals had considerably increased in weight.

Period D.—The actual experiment was then begun. Experiment 14.—This rat was given a watery solution of arsenious acid (containing ½ grain of the poison to the gallon) at the rate of over 1 gallon a day.

Experiment 15.—This rat was given a watery solution of pure ethylic alcohol (containing 5 per cent. of alcohol) at the rate of over 1 gallon a day. The food remained the same as in the previous period (bread and cheese). In both cases the weight of the animal continued to increase, but not so regularly as before the administration of arsenic or alcohol.

Period E.—Duration, 6 days; the same quantity of food was given, but the cheese was stopped. The same solutions were given. In both cases the weight continued to increase for a short time, then it fell slightly.

Period F.—Duration, 6 days; the same fluids being given, the food was reduced to 3 per cent. (a quantity insufficient to maintain the weight under ordinary circumstances). This was followed by a rapid loss of weight, more rapid in the case of the rat taking arsenic than in the case of the rat taking alcohol. The weight of both rats was still above their original weight.

Period G.—Duration, 33 days; the same quantity of food was given, and in Experiment 14 the watery solution of arsenic was continued as before. In Experiment 15 arsenious acid was added to the alcoholic solution, so as to cause the rat to take, in addition to the alcohol, the same amount of arsenic as was taken by rat 14. At the end of the period rat 14 (taking arsenic alone) had lost during the period about 35 per cent. of its original weight, whilst rat 15 (taking both alcohol and arsenic) had lost during the same period about 18 per cent. of its original weight. At that time the weight of rat 14 was less than 90 per cent. of its original weight (70 days previously), whilst the weight of rat 15 was over 98 per cent. of its original weight (70 days previously.

Period H.—Duration, 12 days; the food was continued as before.

Experiment 14.—Alcohol was added to the arsenical solution; this seemed at first to have a beneficial effect, but the weight began again to fall rapidly, and the animal died suddenly at the end of the period.

Experiment 15.—The alcohol solution was replaced by a watery solution of arsenic of the same strength as before, but without alcohol. The rat began immediately to lose weight much more rapidly than before, and at the end of 12 days had lost nearly 20 per cent. of its original weight.

General results of fourth set of experiments and provisional conclusions.

The chief outcome of this set of experiments was that alcohol when given in small doses together with arsenic does not seem to intensify the bad effects of the latter; there is, on the contrary, an indication that alcohol retards the action of arsenic. During the preliminary stages of the experiment rat 14 increased in weight more rapidly than rat 15, and yet at the end of the experiment rat 14 had lost weight to a greater extent than rat 15, which was taking arsenic along with alcohol.

Fifth set.

Fifth Set of Experiments.—These experiments had for object to determine the lethal dose of arsenious acid when the poison was taken under the conditions of the previous experiments. The results have already been discussed at the beginning of this summary, and are also given in Tables I. and II.

Sixth set.

Sixth Set of Experiments.—These experiments had for object to control some of the previous experiments. I had been impressed with the fact that rats generally kept in better health and required less food to maintain their weight when lager beer was administered than when ordinary bitter beer or even water was given to them. In order to ascertain whether this conclusion was correct, I took two rats and gave them each a daily amount of food equal to 5 per cent. of their body weight, *i.e.*, quantity barely sufficient to keep their weight constant when no other drink than water was given to them. I then gave them both for short periods either lager beer or bitter beer at the rate of over 1 gallon daily. Finally I gave one of the rats only lager beer and the other rat only bitter beer for a considerable period. The lager beer contained no arsenic, and about 5 per cent. of alcohol.

The bitter beer contained a trace of arsenic, always less than 1-145rd per gallon (probably never more than 1-200 or 1-250 judging from the sublimates obtained); it contained 6 per cent. of alcohol.

The results obtained may be summed up as follows:—

Period A.—Duration ten days.
Bitter beer, 10 per cent., food 5 per cent.

Experiment 18.—Loss about 15 grammes (out of 145 grammes).

Experiment 19.—Loss about 14 grammes (out of 159 grammes).

Period B.—Duration 14 days.

Lager beer 10 per cent., food 5 per cent.

Experiment 18.—Gain about 5 grammes (upon 130 grammes).

Experiment 19.—Gain about 2 grammes (upon 145 grammes).

Period C.—Duration 15 days.
Bitter beer ten per cent., food 5 per cent.

Experiment 18.—Loss about 10 grammes (out of 135 grammes).

Experiment 19.—Loss about 6 grammes (out of 147 grammes).

Period D.—Duration six days.

Experiment 18.—Lager beer 10 per cent., food 5 per cent.; loss 8 grammes (out of 125 grammes).

Experiment 19.—Bitter beer 10 per cent., food 5 per cent. ; loss 11 grammes (out of 141).

Period E.—Duration 45 days.
Beer 10 per cent., food 8·5 per cent.

Experiment 18.—Lager beer ; gain 23 grammes (upon 117 grammes).

Experiment 19.—Bitter beer ; loss 19 grammes (upon 130 grammes), death.

After this period the rat 18 continued to increase in weight for several days, but then became suddenly ill, would not take its food, and died 105 days after the beginning of the experiment. The illness was entirely different from that observed in rats dying from the effects of arsenic, the animal refusing to take its food and drink, whilst the arsenical rats although they frequently left variable amounts of food and drink, usually ate up to the last day and died suddenly. Death in this case was due to an accidental illness, which began at a time when the animal was rapidly increasing in weight.

This set of experiments confirmed my impression that bitter beer drunk at the time of the outbreak in Salford and in Manchester was less wholesome than lager beer imported from Munich.

Whether this difference was attributable to the small trace of arsenic present in the beer, or the difference between the products of high and low fermentation, I am not prepared yet to say, but my general impression is that beer brewed at a low temperature is more wholesome than beer brewed at a high temperature. It is also to be noticed that the bitter beer used in this set of experiments was beer which would have passed easily the test recommended by the Brewers' Commission.

Seventh Set of Experiments.—For purposes of comparison I have brought together four experiments carried out previously in my laboratory by Dr. Kerr, and which had for object to ascertain the effect of the administration of large doses of pure ethylic alcohol, on the liver.

Experiment 20 (xxii.).—A rat weighing 180 grammes was given daily 10 per cent. of its body weight of dry food, and 3·2 per cent. of a 25 per cent. solution of pure ethylic alcohol, or about 0·80 per cent. of its body weight of absolute alcohol. The fluid was given by the mouth. Appendix A

During the first 6 days it lost about 27 per cent. of its weight, but began to gain flesh again. On the 52nd day the loss had been reduced to 16 per cent.

Experiment 21 (xxvii.).—A rat weighing 150 grammes was given daily 10 per cent. of its body weight of dry food and 2·7 per cent. of its body weight of a 20 per cent. watery solution of pure ethylic alcohol (0·54 per cent. of body weight in absolute alcohol). This fluid was injected into the rectum.

After an initial diminution, the weight increased again.

Sixty-nine days after the beginning of the experiment, when the animal was killed, its weight was only 6 per cent. lower than the original weight.

Experiment 22 (*III.*).—Rat weighing 150 grammes. Experiment conducted as in the previous case (daily dose of absolute alcohol 0.51 per cent. of body weight). The animal was killed 69 days after the beginning of the experiment ; the loss of weight was about 30 per cent. of the original weight.

Experiment 23 (*V.*).—Rat weighing 154 grammes. Experiment conducted as in the two previous cases (daily dose of absolute alcohol 0.35 per cent. of body weight). This animal did not bear the administration of the alcohol well, and died on the 63rd day, there being a loss of 45 per cent. of the original weight.

Summary of the Results of the 7th Set of Experiments.— Summary.
These animals showed frequent evidences of intoxication, so that the administration of a fluid containing 20 or 25 per cent. of absolute alcohol, produced effects which were not observed in rats to which an equal amount of alcohol was given in a more diluted state. The effects of alcohol were also more variable than those of arsenic. Two of the rats appeared to recover gradually from the first effects of alcohol, and to regain weight ; two other rats continued to lose weight from the first. Only one of the four died, and that animal seemed from the first to be very sensitive to the action of alcohol ; possibly it was not in a good state of health at the beginning of the experiment. To insure the rapid passage of the alcohol into the circulation, the alcohol solution was in three out of the four cases injected into the rectum ; this caused intestinal irritation, which complicated the action of alcohol. Owing to this disturbing element, experiment 20 is the only experiment in this set which is quite comparable with the experiments on arsenic.

B. ESTIMATION OF THE AMOUNT OF ARSENIC PRESENT AT THE TIME OF DEATH IN THE TISSUES OF RATS WHICH HAD BEEN TAKING ARSENICAL FLUIDS.

After the death of most of the rats used in these experiments a post-mortem examination was made. The stomach and intestines were removed in all cases, as well as portions of the lungs, a part of the liver, both kidneys, a small part of the spinal column, and spinal cord, the diaphragm, a portion of the muscles, nerves, and bones, of one of the extremities. These parts were kept for microscopial and microchemical examination. The remainder of the body was then used for chemical estimation.

In some cases these remains were entirely reduced to pulp, care being taken to avoid accidental contamination, and this pulp was then macerated either in water or in 20 per cent. hydrochloric acid for 24 or 48 hours, the quantity of fluid being brought at the end of that time up to 50 cc., 100 cc., or 150 cc. (according to the quantity of material), either by the addition of 20 per cent. of hydrochloric acid, when dilute acid had been used from the first (which was generally the case), or by the addition of pure hydrochloric acid up to 20 per cent. of the whole amount of fluid used, when pure water had been used as a macerating fluid.

The mixture was then treated according to the method which I have devised for estimating the amount of arsenic in beer on the basis of Reinsch's process. In other cases the skin was separated from the other tissues, and the amount of arsenic in it was estimated in the same way.

In another group of cases a square patch of skin was removed from the back of the animal, the hair was then removed from that patch, and the arsenic estimated separately in the hairless skin, and in the hair. The skin of the back was selected for that purpose as being the least exposed to accidental contamination from the food and drink taken by the animal. In one case the amount of arsenic present in the liver was also estimated. All the parts used were weighed so as to make it possible to calculate roughly the amount of arsenic in the whole body. For several reasons I did not entertain great hopes of obtaining accurate results ; at the time the analyses had to be made I had not been able to determine how far the amount of arsenic separated by Reinsch's process from fluids containing blood, hair, muscles, etc., would bear a ratio to the total amount of arsenic present in these parts comparable to that which I had determined in the case of beer. The beer standard had therefore to be used. Then, owing to the difficulty of boiling fluids containing a large amount of proteid substances, Dr. Coutts, who carried out the estimations for me, had to vary the proportion of the dilute acid to the matter analysed. This must, to a certain extent, have influenced the proportion of arsenic precipitated upon the copper. Thirdly, the sublimates obtained in several cases were less abundant than my lowest standard (1—10,000,000) sublimate, so that we were deprived of means of accurate comparison. This was due to the very small amount of material available in some cases.

For all these reasons it is obvious that the quantities which are recorded in Table 1 are not strictly comparable with those obtained in connection with the beer, moreover, they are not exactly comparable among themselves.

It has appeared to me, however, that, imperfect as they are, the figures obtained would be more useful than a mere statement that arsenic had been found to be present or absent. Notwithstanding all their defects these estimations revealed clearly the fact that the amount of arsenic present in the body after death bore some relation to the amount of arsenic taken during life. Summary of results of chemical estimations.

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CALCULATED Amount of Arsenic found in the Body after Death, compared with the Amount of Arsenic given during Life.

Experiment.	Total Amount of Arsenic given during Life per cent. of body weight. As As_2O_3	Amount of Arsenic taken Daily per cent. of body weight. As As_2O_3.	Apparent Total Amount of Arsenic* found P.M. in the body. Estimated in As_2O_3.	Weight of Animals P.M.	
	Grammes.	*Grammes.*	*Grammes.*	*Grammes.*	
1	0·0034300	0·0000390	0·0000368	90	Salford beer stopped 42 days before death.
6	0·0000706	0·0000008	0·0000144	144	Bitter beer stopped 44 days before death.
7	0·0176000	0·0007600	0·0000773	122	Arsenical beer taken till time of death.
8	0·0632000	0·0007700	0·0004000	100	- - ditto - - - ditto.
9	0·0058000	0·0001055	0·0000282	142	- - ditto - - - ditto.
10	0·0132720 Kd.	0·0001680 Kd.	0·0000767	307	Cacodylate taken till the time of death.
11	0†	0†	0·0000060	243	Water and beer supposed to be arsenic free taken up till time of death.
14	0·0046150	0·0000710	0·0001150	66	Arsenic taken up till time of death.
15	0·0031950	0·0000710	0·0000749	77	- - ditto - - - ditto.
16	0·0120000	—	0·0008050	125	Death two days after second dose of arsenic.
18	0·0000240	0·0000010	Trace	115	Lager beer taken up to time of death. Bitter beer stopped 50 days before death.
19	0·0000740	0·0000010	Trace	111	Bitter beer taken up to time of death.

* All the analyses upon which I have based the calculations in this column are based upon the estimations made for me in my laboratory by Dr. Coutts, the method which I have devised for estimating the amount of arsenic in beer being used in every case. The figures given in the first two columns are practically accurate since they represent the exact amount of arsenic given to the rats, except in the case of experiments 1, 6, 18, and 19, in which the amount of arsenic present in the beer was also ascertained by my method.

† Since making the above experiments I have examined again lager beer from the same source as that from which I obtained the beer used in these experiments and have found distinct traces of arsenic in some of the samples.

Evidence of accumulation of arsenic in the tissues.

Usually the amount calculated for the whole body was below that of one daily dose administered during life. But when the daily dose was less than 0·00007 grammes (per cent of body weight) the amount estimated to be present P.M. was more or less in excess of the daily dose. The smaller the dose the more marked this excess seemed to be. Two interpretations may be given to this; either this excess is evidence of experimental error, or else it indicates that arsenic when administered in small doses can accumulate up to a certain point in the tissues.

Experiment 11 seems to support the first view, for this rat had taken during life only water and beer which appeared to be quite free from arsenic, and yet after death a recognisable trace of arsenic was discovered in the tissues. It is, however, possible that although it was impossible to detect arsenic in the fluids given to the rat, there were nevertheless very minute quantities of the poison which could not be detected in the quantities used for analysis. Admitting that the figure 0·000006 indicates the result of some experimental error which may have tainted all the other estimates, it will be noticed that such an error would not explain the excess found in Experiments 6, 14, and 15.

Limitation of accumulation. Saturation of tissues.

The evidence, therefore, as far as it goes, seems to indicate that arsenic may accumulate in the tissues up to a certain point. That the tissues are not capable to retain more than a certain amount of arsenic seems also to be indicated by the fact that whenever large doses of arsenic were administered, even up to the time of death, the amount of arsenic found in the body after death was invariably smaller than the amount of arsenic given daily. These results seem to indicate that arsenic forms some kind of compound with tissue elements.

Another interesting fact is brought out by these estimations. Arsenic was found in the tissues of two rats which had ceased to take arsenic for more than 40 days before death. In experiment 1 the amount found was nearly equal to a daily dose. In experiment 6 the amount of arsenic found was 16 times greater than a single daily dose. The daily dose in this case was exceedingly small.

To account for these results it is almost necessary to suppose that arsenic enters into combination with some of the constituents of protoplasma.

When large doses are given it is probable that a portion of the arsenic passes out of the body with the fæces, and that portion of what passes into general circulation not being retained by the tissues is excreted by the skin, liver, kidneys, and other glands. This view is supported by actual observation in the human subject. I made several attempts to collect the urine and fæces of rats taking arsenical fluids, but I was not successful in devising a plan excluding the possibility of contamination of the excreta with the fluid administered to the animals.

Localisation of arsenic in the tissues.

With regard to the localisation of arsenic in the tissues, I have not been able to make many observations, but the results summed up in the following table are suggestive:—

AMOUNT of Arsenic in parts per 10,000,000.

Experiment.	Body with part of Skin.	Body without Skin.	Skin and Hair.	Skin without Hair.	Hair alone.	Liver.
1	—	3 to 4	10?	—	18?	—
2	—	—	—	15	25?	—
3	—	—	—	21	300?	—
4	—	—	—	10	900?	—
6	1	—	—	—	—	—
7	4	—	23	—	—	6?
8	40	—	—	5?	30?	—
9	—	1?	—	6—8	8?	—
10	2·5?	—	—	—	—	—
11	0·25?	—	—	—	—	—
14	10 to 15	—	80	—	—	—
15	—	10	5 to 8	—	—	—
16	Over 68	—	—	—	—	

Note.—(?) indicates that the estimation were subject to more experimental fallacies than usual.

In Experiments 3 and 4 the rats were taking large doses of arsenic, and it is probable that their skin had more than once been wetted by the fluid given to the animals to drink.

On the whole the results confirm those of other observers with regard to the special tendency which arsenic has to accumulate in the skin, and more especially in the hair.

The amount of arsenic found in the body of the rats taking small doses of arsenic corresponds to the amount we found in some of the organs of patients that had died from the effects of arsenical beer (the same method of analysis having been used).

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Ref. No.			
107	- -	Thyroid Body -	less than 5 in 10,000,000
124	- -	Bones - - -	about 4 in 10,000,000
125	- -	Spleen - - -	about 1 to 2 in 10,000,000
126	- -	Thyroid Body -	about 7 to 8 in 10,000,000

The material at my disposal did not allow me to push the comparison further.

Conclusions based on chemical examination.

Generally speaking, the results of the estimation of arsenic in the experimental rats confirm the view that arsenical beer, such as was drunk during the outbreak, acted in the same way as solutions of arsenious acid containing about the same quantities of arsenic as those which I had estimated to be present in that beer. Watery solutions of arsenious acid appeared, however, to be more toxic than beer containing the same amount of arsenic.

C. LESIONS FOUND AFTER DEATH IN RATS WHICH HAD BEEN TAKING VARIOUS FLUIDS CONTAINING DIFFERENT PROPORTIONS OF ARSENIC. COMPARISON OF THESE LESIONS WITH THOSE OBSERVED IN PERSONS WHO HAD DIED FROM THE EFFECTS OF ARSENICAL BEER.

I have previously (Questions 5303 to 5315) alluded to some of the changes which have been observed in persons that had died from arsenical poisoning resulting from the consumption of beer* :—

Among the changes, some were, in my opinion, evidences of the action of deteriorating influences, such as imperfect feeding and disease (more especially tuberculosis). Another group of lesions seemed to me to be special and common to the majority of cases of arsenical poisoning, and consequently to be attributable to the action of arsenic.

Among these lesions the most important were—first, degeneration of the more specialised tissues, such as glandular epithelium, muscular and nervous tissues (these degenerations lead to wasting and perturbation of functional activities); second, irritation and increased proliferative activity of the less specialised tissues, such as connective tissues and certain epithelial tissues (these changes lead to fibrosis, keratosis, pigmentation, etc.).

(See my evidence in Vol. I. of Commission's Minutes.)

In order to acquire more information than we possess at present on these points I have arranged for investigations to be carried out with the material collected for me chiefly by Dr. Moore, assistant lecturer in my department at Owen's College. Several of my pupils have undertaken at my request to investigate in detail the changes observed in various organs. I have already related the general changes observed by Dr. F. C. Moore in the autopsies which he conducted (see Table X.). Dr. J. C. Muir has completed an investigation on the blood and bone marrow of many cases; he has given an excellent account of his work. Dr. W. F. Jackson has completed a research on the changes occurring in the kidneys. He has found that congestion, some degeneration of epithelium, and possibly in some cases accumulation of melanin in some of the secreting cells might be attributed to the action of arsenic. Dr. Reginald Lawrence has carried out an examination of the nerve centres, which brings out the fact that nerve cells are invariably affected by arsenic, and are the seat of degenerative processes. The investigations relating to the liver, lungs, skin, lymphatic glands, muscles, and fat are not yet complete. If desired to do so, I will submit the reports which are at present available. I may say generally, on the basis of my own preliminary examinations, that the following changes were of common occurrence among the victims of arsenical beer :—

1. General hyperæmia, most noticeable in the lungs, glands, muscles, and nerve centres.

2. Considerable degeneration and wasting of some of the muscles examined.

3. Albuminous and fatty degeneration of the cardiac muscle, patchy and often slight.

4. More or less complete disappearance of fat from some of the cells of fatty tissue.

5. Albuminous and fatty degenerations of glandular epithelium, specially well marked in the liver.

6. Degeneration of nerve tissues most marked in the nerve cells of the cerebral cortex and the spinal cord. The terminal nerves seemed also to be affected in a few cases, but I am not certain whether the changes were attributable to arsenic or to some other causes; in several cases no clear evidence of degeneration of peripheral nerves could be found.

7. Over production of melanin in the deep layers of the epidermis, accumulation of melanin or of an allied pigment in the lymphatics of the true skin, in lymphatic glands, in some connective tissue cells, and possibly in some glands—*e.g.*, the liver and kidney. In the present state of our knowledge it is not however quite possible to determine whether a pigment resembling melanin is certainly melanin without further investigation.

8. Sometimes there was over-production of cutaneous epithelium, also keratosis, and of fibrous tissue in some of the organs, which were also the seat of degenerative processes. With regard to the latter change, it was generally difficult to exclude the possible influence of other causes.

Changes observed in rats.

The post-mortem examinations which I have made of the rats used in the experiments which have been previously related, have yielded very similar results. In fact, with one exception, the changes observed in the various organs and tissues have been of the same nature as those found in the human subject; but with regard to pigmentation, I have obtained no result. I expected this difference, for all my experimental rats were albino rats; the absence of pigmentation in these cases is an additional confirmation of the theory which I have formulated many years ago regarding the origin of melanin. At the time when I started my experiments I tried to obtain some tame grey rats, but I was not able to get any. It would have been impossible to conduct carefully systematic experiments with wild rats. A detailed account of these pathological investigations is not yet ready, and would not in its present state add materially to the value of the evidence which I have already obtained.

There remain in my mind no doubts regarding the similarity between the lesions observed in the bodies of patients who have died of the effects of arsenical beer, and the lesions observed in the carcases of rats to which solutions of arsenious acid in water or in beer had been given, over periods varying from 30 days to 90 days. Several of these cases had not taken proportionately more arsenious acid than the human victim. The mode of death in both cases was usually sudden, as if due to cardiac failure, or failure of the respiratory muscles. It is also noticeable that when small quantities of arsenic were given, a fatal result did not usually occur before the end of three months, and that slow recovery was possible at the end of that time.

Watery solutions of arsenious acid compared with arsenical beer.

The experiments on rats had also the object of determining whether arsenious acid in beer was more poisonous than arsenious acid dissolved in water. The changes of weight observed in animals taking equal amounts of arsenious acid dissolved in beer or in water, had already shown that arsenious acid dissolved in water seems to be more injurious than arsenious acid dissolved in beer; the post-mortem examinations confirmed this view, for the degenerative changes were most marked in rats taking watery solutions of arsenious acid.

* It must be remembered that most of these patients were also suffering from other illnesses, the majority of them were tuberculous. In some there was some pyrexia.

Appendix 16.

Influence of alcohol.

Alcohol up to the amount usually present in beer did not seem to affect the rats unfavourably, but the addition of alcohol up to 10 per cent. of the total fluid seemed in one case to have a detrimental effect. The bad effects obtained with strong solutions of alcohol, even in moderate quantities, indicated that dilution has an important influence upon the results.

Action of cacodylate of sodium.

With regard to the possible presence of arsines in arsenical beer, cacodylates seemed to me to be among the most noxious arsines * which could reasonably be expected to be present in beer, the results obtained in the only case in which cacodylate of sodium was administered were so much in accordance with what was known before of the physiological action of this salt that I did not think it necessary to multiply experiments. Far from having a detrimental effect during periods comparable to those of the Salford epidemic, cacodylate of sodium seemed to have a beneficial effect even when administered in large doses, the animal treated with cacodylate of sodium bore better the effects of low diet than a control animal taking no arsenic at all. Another rat receiving as much arsenicum, in the form of arsenious acid as the cacodylate rat became, on the contrary, seriously ill under the same collateral experimental conditions. The post-mortem state of organs agreed with the symptoms during life. In the rat receiving arsenious acid, and which died in consequence, the usual degenerative changes were observed, and the fat of the fatty tissue had disappeared entirely from one of the parts where it is usually found. The cacodylate rat, on the contrary, was apparently quite well when killed its organs had a normal appearance, and there was the usual amount of fat under the skin and in other situations.

D. GENERAL SUMMARY OF EXPERIMENTAL RESULTS.

(D.) General summary of experimental results.

In all the experiments from which these conclusions are drawn, the animals were taking arsenical fluid at a rate which corresponded to over one gallon for a man weighing 140 lbs.

1. Beer to which had been attributed several human cases of arsenical poisoning during the 1900-1901 outbreak in Salford, produced in rats lesions characteristic of arsenical poisoning. The quantity of beer necessary to produce this result was not proportionally larger than the quantity taken by a great number of the persons attacked. (Experiment 1, also Table I., in Appendix to my previous evidence in Vol. I. :—Beer A, B, C, 71, 72, IX.)

2. The same effects may be produced by the administration of beer containing the same amount of arsenic introduced by the use in brewing of glucose obtained from Messrs. Bostock's factory (Experiment 9).

3. Similar effects, but more rapid and intense, can be produced by watery solutions of arsenious acid containing the same amount of arsenicum as arsenical beer brewed from arsenical glucose (Experiments 2 and 14).

4. Beer containing traces of arsenic introduced by the use of badly prepared malt does not produce effects approaching those produced by arsenical glucose beer; there is, nevertheless, some evidence to show that even the smaller quantities of arsenic introduced by arsenical malt may have a detrimental effect. (Experiment 6 and 19 and Table II. Malt, in Appendix to my evidence in Vol. I., *see* Malts 83, 84, 87, 89, 90, 91, 92, 97, 98.)

5. Beer to which arsenious acid has been added so as to make the proportion of arsenic about four times greater than that present in badly contaminated samples of original arsenical beer (so as to make the dose administered to rats comparable to the doses taken by beer drinkers) invariably produced chronic arsenical poisoning, fatal in less than three months from the beginning of the administration (Experiments 3, 5, and 8.)

6. Solutions of arsenious acid in water, containing the same quantity of arsenic as the beer referred to in Sec. 5, acted in the same way, but more rapidly and intensely. (Experiment 4.)

7. Solutions of arsenious acid in water, containing from 70 to 140 times more arsenic than had been found in the most arsenical beer examined in the laboratory, produced acute arsenical poisoning. (Experiments 16 and 17.)

8. The presence of from 5 to 6 per cent. of ethylic alcohol in the arsenical fluid did not seem to have a material influence upon the action of the arsenic. (Experiments 1, 3, 14, and 15.)

9. The presence of 10 per cent. ethylic alcohol seemed in one experiment to have a detrimental effect, but, judging by the bad effects of alcohol alone, administered in 20 and 25 per cent. dilutions, it seems likely that the effects of alcohol are superadded to those of arsenic, and unlikely that the toxicity of arsenic is exalted by the presence of alcohol. (Experiments 6, 7, 8, 20, 21, 22, 23.)

The quantity of alcohol present in ordinary bitter beer does not seem to have materially influenced the course of the outbreak.

10. The administration of large doses of cacodylate of sodium dissolved either in beer or in water does not produce deleterious effects comparable to those produced by arsenical beer.†

11. As long as growing rats received a large amount of food (7 to 10 per cent. of their body weight) the presence of a small amount of arsenic in their drink did not appear to have any detrimental effect; on the contrary, the rate of weight increment seemed to be increased. By reducing the amount of feed to a quantity barely sufficient to maintain a normal rate of increment (3 to 5 per cent. of their body weight), rats taking even a minute quantity of arsenic were liable to an abnormally rapid loss of weight, and soon became ill.

12. When the amount of arsenious acid reached the proportion of 7 grains per gallon, the effects of arsenic were not much influenced by the amount of food taken, and after a few days even the complete stoppage of arsenic did not bring about a rapid improvement in the condition of the animal. The reverse was true when small doses of arsenic were taken.

13. The effects of arsenical beer were evident for days after the administration of the fluid had ceased. In one case the replacement of moderately arsenical beer by arsenic-free fluids was followed by an aggravation in the state of the animal (Experiment 1). Rat No. 1 had taken arsenical beer containing 1-6th grain of arsenious acid per gallon almost daily for 102 days. When it died 42 days later there was still a considerable amount of arsenic in its tissues.

14. The tissues are capable of retaining a certain amount of arsenic, and my experiments indicate that, even when very small doses of arsenic are administered, the poison may accumulate until a certain limit is reached. When arsenic is administered in large doses there seems to be no proportional accumulation, because the amount of arsenic retained by the tissues is usually less than the amount administered in one dose.

I wish to give this last conclusion with some reserve, as I feel that it should be tested by more accurate analyses than those which have so far been carried out in my laboratory. I think, however, that, imperfect as they are, the results indicate clearly the conclusions to which I have arrived.

(*See* table of calculated amount of arsenic found in the body after death, given above.)

* The action of various combinations of arsenic with alcohol radicals has been studied by several physiologists (a summary of these results is given by E. Wertheimer in "Richet's Dictionnarie de Physiologie," 1895, p. 701). Cacodylic acid has been shown to be toxic by Lehahn, H. Schulz, Rabuteau. The action of cacodylic acid resembles that of arsenical compounds generally, but this compound is much less poisonous than arsenious acid. Schulz, Schroetter, and Rabuteau have also studied the action of other organic compounds of arsenic, and have found them less poisonous than arsenious acid. (In discussing the lesions produced by arsenic in man and rat, I have mentioned only those changes which have allowed me to recognise identity of action; the above statements do not deal with the pathology of arsenical poisoning; I do not intend to give an account of that part of my inquiry before the examination of all the material at my disposal has been completed. I may, however, submit, if desired to do so, photographs illustrating some of the lesions already observed.)

† Although the matter is comparatively irrelevant, it is worth noting, 1st, that cacodylate of sodium seemed to have a distinctly beneficial action; 2nd, that beer appeared to act as a food, and that in ill-fed animals the toxic effects of arsenic were to a certain extent reduced by the other constituents of beer.

E. GENERAL CONCLUSIONS OF EXPERIMENTAL INVESTIGATIONS.

1st. The 1900-1901 outbreak was due to the presence of arsenious acid in the beer drunk by the victims.

2nd. The presence of an amount ($\frac{1}{25}$ to 2 grains per gallon) of arsenious acid capable of producing such an outbreak can only be accounted for by the use of arsenical glucose or invert sugar as malt substitutes.

3rd. The presence of smaller quantities ($\frac{1}{10}$ to $\frac{1}{25}$ grain per gallon) of arsenious acid, such as may be due to the use of badly prepared malt, though seldom dangerous to the same extent, is capable of producing injurious effects in ill-fed or weak individuals. I am therefore of opinion that the amount of any food or drink, which may be taken daily by any consumer, should never contain more than $\frac{1}{10}$ grain of arsenic (estimated as $As_2 O_3$). I would even prefer to see the amount of arsenic allowable daily reduced to $\frac{1}{20}$ grain.

4th. Bad feeding and other deteriorating influences are sufficient to account for the special incidence of cases of poisoning among classes of people liable to these influences.

(Conclusions 1 and 2 are in perfect agreement with those I gave to Dr. Tattersall on the 27th of November, 1900. Conclusions 3 and 4 are based on observations which were made during the following month, and were partly communicated to the members of the Royal Commission over one year ago (March, 1901). These conclusions have been further confirmed by experimental work extending over the greater part of the year. Finally, when I speak of arsenious acid as being present in beer, I do not wish to convey the idea that some loose compound may not be formed between arsenious acid and some of the constituents of beer. Arsenious acid in watery solutions can be easily detected by the Marsh's test, without previous treatment of the solution, but a solution of arsenious acid in beer does not give the same results. This might be said to indicate the existence of some loose organic combination, but such an inference would be purely hypothetical. What is absolutely clear is that the poisonous action of beer containing arsenic resembles closely that of arsenious acid or arsenites, and not that of arsines.

S. DELÉPINE.

FURTHER NOTE AS TO DEVELOPMENT OF PARALYSIS IN RATS RECEIVING ARSENIC.

Sent to the Commission by Professor Delépine, January, 1903.

With reference to my answer to Dr. Whitelegge in (Q. 10420), I wish now to add that at the time when I gave this evidence I had only begun experiments upon the action of larger doses of arsenic than those given in beer or water. In the new set of experiments, the arsenic was administered with the food, and the average daily doses were at least three times larger than the doses given in any of the previous experiments (except the experiments on acute poisoning, Set V.). The total amount of arsenic taken by each one of the rats in the new series was larger than that taken by any of the previous rats (including those which had taken acutely poisonous doses). In three of the rats of the new series (Series VII.) which lived more than three or four weeks, symptoms of chronic arsenicism, similar to those observed in arsenical beer drinkers, were observed. See appended Table IV., which is a summary of observations made partly by myself and partly by Drs. Butterworth and Melling under my direction.

It is probable that when smaller doses of arsenic were used, the paralytic symptoms were too slight to be clearly recognisable in an animal such as the rat.

TABLE IV.

Set VII. Later set of experiments, arsenic being administered with food, and the dose made at least three times larger than the largest dose administered in beer or water in the previous sets of experiments I. to VI.:

No. of experiment.	Original weight of guinea pig.	Average weight of food per cent. of body weight. Daily quantity taken.	Average daily dose of arsenic, per cent. of body weight.	Duration of experiment.	Daily average loss per cent. of body weight.	Remarks and symptoms of arsenicism evidenced during life.
	Grammes.	*Grammes.*	*Grammes.*	*Days.*	*Grammes.*	
1272 A	290	6·3	0·0023	38	1·8	(Some daily doses rose to 0·0035 gramme per cent. just before death). Paralysis of extensor muscles of front paws (position of paws similar to that of hand in wrist-drop) marked conjunctival hyperæmia, œdema of eyelids.
1286 A	180	7·	0·0024*	45	0·86	Daily doses rose occasionally above 0·004 gramme per cent. Extensive paralysis of front paws, conjunctivitis.
1286 B	133	8·3	0·0024*	21	0·10	Daily doses amounting to 0·004 gramme per cent. were given for five consecutive days up to the third day previous to death. Extensive paralysis of front paws, conjunctivitis, œdema of hind limbs and tail.

These animals exhibited in addition the swelling of nasal mucous membrane, drowsiness, unsteady gait at times, redness of plantar skin, which had also been observed in nearly all the rats previously experimented upon to which much smaller doses had been given.

* A dose of 0·0024 gramme per cent. would correspond to one of 1·5 gramme to a man weighing 63,300 grammes, or a little less than 140 lbs. Such a dose would be rapidly poisonous for a man.

Appendix 16.

TABLE I.

GENERAL or GROSS RESULTS of EXPERIMENTS

Set.	Number of Experiment.	Original weight of rat.	Nature of fluid given to the animal.	Quantity per cent. of body weight.	Proportion of Arsenic.		Average Amount of Dry Food taken daily per cent. of body weight.	Total Amount of Arsenic taken during experiments per cent. of body weight, as As_2O_3.	Total Amount of Alcohol taken during experiment per cent. of body weight
					Per 10,000,000, as As_2O_3.	Per Gallon (Grains) about.			
		Grammes.							
I.	1. (1115)	117	Salford arsenical beer (A) alcohol about 5 to 6 per cent.	16	25	$\frac{1}{4}$	7·6	0·0034300	86·7
	2. (1117)	125	Watery solution of arsenious acid -	8	20	$\frac{1}{4}$	7·5	0·0009000	0
	3. (1116)	130	Salford arsenical beer (A) + arsenious acid after a time (36 days)	8	1,000	7	7·	0·0307000	30·
	4. (1125)	168	Watery solution of arsenious acid, full strength on 36th day only.	8	1,000	7	6·4	0·0320960	0
	5. (1118)	121·5	Munich lager beer - - - - -	16	0	0	The latter part of this experiment was spoilt		
II.	6. (1131)	160	Bitter beer very slightly arsenical with alcohol added up to 10 per cent.	8	Under 1	Under $\frac{1}{14}$	7·2	0·0000706	108·6
	7. (1132)	181	Bitter beer with alcohol added up to 10 per cent. and arsenic up to 7 grains to a gallon.	8	1,000	7	7·2	0·0170000	20·
	8. (1133)	189	Bitter beer, alcohol driven off, arsenic added up to 7 grains to a gallon.	8	1,000	7	6·4	0·0032000	0·
III.	9. (1141)	255	Beer brewed in laboratory from Postock's arsenical glucose, alcohol about 6 per cent.	8	132	$\frac{1}{2}$	4·8	0·0058000	26·4
	10. (1140B)	284	Solution of cacodylate of sodium in water or arsenic free beer.	8	Kd. 210	Kd. 1·47	5·6	Kd. 0·0132720	15·60
	11. (1139)	229	Water or arsenic free lager beer -	8	0	0	5·6	0 ?	20·40
IV.	14. (1173)	121	Solution of arsenious acid in water without alcohol.	10	71	$\frac{1}{2}$	5·6	0·0046150	0·
	15. (1174)	113	Solution of ethylic alcohol in water, arsenic added after 19 days. (For both 14 and 15 the animal was kept under observation for 18 days before the beginning of the experiment.)	10	71	$\frac{1}{2}$	5·6	·0031959	26·5
V.	16. (1179)	141	Solution of arsenious acid in water -	6	10,000	70	5·	0·0120000	0·
	17. (1175)	135	—— (Arsenious acid 140 grains per gallon).	6	20,000	140	5·	0·0120000	0·
VI.	18. (1179A)	145	Arsenic free lager beer (bitter beer given on two occasions for short periods).	10	—	—	6·5	0·0000240	61·8
	19. (1179B)	159	Bitter beer with trace of arsenic (lager beer given for short period).	10	Under 1	Under $\frac{1}{14}$	6·5	0·0000740	51·90

REMARK.—In interpreting the results it must be remembered that a healthy rat not fully grown and given only water to drink almost always loses weight when the amount of dry food given to it falls below 4 per cent. of the body weight. It may maintain its weight when given 5 or 6 per cent. of food, it gains weight when the amount of food reaches 10 per cent. Experiments 12 to 13, which were made on very young rats, were discarded because the animals never took their food and drink well and regularly. Experiments on very young rats had to be entirely abandoned on that account.

TABLE I.

Appendix 16.

on the ACTION OF ARSENIC and ALCOHOL.

Number of days during which the Special Fluid was taken.	Total duration of Life.	Weight at Death per cent. of original weight.	Daily Loss — or Gain + per cent. of original weight.	Apparent Cause of Death, when animal was not killed.	Result of Analyses of Body, Skin, Hair, &c.		
					Parts analysed.	$As_2 O_3$ parts per 10,000,000. ⊛	Quantities used for Analyses.
							Grammes.
93	144	78·3	— 0·15	Animal killed	Body without viscera	3 to 4	55·8
					Skin with hair	10 ?	2·46
					Hair	18 ?	1·34
71	88	74·4	— 0·30	Chronic poisoning	Skin (shaved)	15	3·15
					Hair alone	25	2·05
80	89	71·5	— 0·32	Chronic poisoning	Skin (shaved)	21	4·58
					Hair alone	300	2·6
61	91	57·	— 0·47	Chronic poisoning	Skin (shaved)	10 ?	3·04
					Hair alone	200 ?	2·39
owing to the animal having young (*see* comparable periods).							
81	135	90·	— 0·07	Killed	Body with skin	1	11·6
27	36	67·	— 0·90	Chronic poisoning	Body	4	74·3
					Liver	6 ?	4·06
					Skin and hair	23	8·57
81	91	58·1	— 0·46	Chronic poisoning	Body	40 ?	59·0
					Skin	5 ?	5·0
					Hair	30 ?	1·0
56	68	55·	— 0·66	Chronic poisoning	Body	1 ?	84·0
					Skin	6 to 8	6·0
					Hair alone	8 ?	3·0
81	93	107·8	+ 0·68	Killed	Whole body	2·5 ?	260·
51	93	105·4	+ 0·65	Killed	Whole body	0·25 ?	210·
65	65	54·5	— 0·70	Chronic poisoning	Body and part of skin	10 to 15	41·
					Skin and hair	80	4·75
65	66	69·9	— 0·46	Killed, when already ill	Body without skin	10	43·
					Skin	5 to 8	6·72
3	4	90·7	— 2·32	Acute poisoning	Body without liver, stomach, or intestines.	over 68	75·
1	4	85·	— 3·75	Acute poisoning	——	—	—
79	102	79·	— 0·20	Acute illness, accidental	Whole body	Trace.	—
89	89	69·	— 0·34	Slow illness, chronic poisoning.	Whole body	Trace.	—

⊛ These figures have no absolute value and are not even quite comparable. Those results which are most doubtful have been indicated by queries.

N.B.—All the quantities given, except the original weight of the rats and the proportion of arsenic in the fluid administered, are expressed in terms of the weight of the body. The weight of the body having been reduced to a uniform weight of 100 grammes (the young white rats weighed usually from 100 to 150 grammes, the fully-grown ones from 200 to 300 grammes). Knowing that a man of average weight weighs about 140 lbs. or 63,504 grammes, it is easy to obtain an idea of what a man would have to eat or drink in order to take quantities comparable to those taken by the rats; in the same way the amount of arsenic, loss of weight, &c., may be calculated. The weight of a gallon of beer is $\frac{1}{20}$th part of that of a man weighing 140 lbs. or 7·14 per cent. A glance at this table will show that the quantity of beer given to the rats was generally 8 per cent. of the body weight, corresponding therefore to more than 1 gallon for a man 140 lbs. in weight.

Appendix 16.

TABLE II.

RESULTS of EXPERIMENTS during COMPARABLE GROUPS of

Set.	Number of Experiment.	Original Weight of Rat. Grammes.	Nature of fluid given to the animal.	Quantity of fluid *eaten* per Cent. of Body Weight.	Proportion of Arsenic: Per 10,000,000 As As_2O_3.	Proportion of Arsenic: Per Gallon Grains (about)	Weight at the beginning of the period.
I.	1 (1115)	117	Salford arsenical beer (A) alcohol about 5 to 6 per cent.	16	25	$\frac{1}{4}$	133
	2 (1117)	125	Watery solution of arsenious acid.	8	20	$\frac{1}{7}$	149·3
	3 (1116)	190	Salford arsenical beer A + arsenious acid after a time (36 days).	8	1,000	7	213·3
	4 (1125)	168	Watery solution of arsenious acid, full strength on 36th day only.	8	1,000	7	168
Spoilt experiment.	5 (1118)	121·5 This animal was ill the greater part of the time.	Munich lager beer - - -	16	0	0	121·5
II.	6 (1131)	160	Bitter beer, very slightly arsenical, with alcohol added up to 10 per cent.	8	under 1	under $\frac{1}{14}$	160
	7 (1132)	181	Bitter beer, with alcohol added up to 10 per cent., and arsenic up to 7 grains to a gallon.	8	1,000	7	181
	8 (1133)	189	Bitter beer, alcohol driven off, arsenic added up to 7 grains to a gallon.	8	1,000	7	189
III.	9 (1141)	255	Beer brewed in the laboratory from Bostock's arsenical glucose; alcohol about 6 per cent.	8	132	$\frac{13}{14}$	254
	10 (1140B)	284	Solution of cacodylate of sodium in water, or arsenic free beer.	8	[Kd. 210]	[Kd. 1·47]	297
	11 (1139)	229	Water or arsenic free ale beer.	8	0	0	232
IV.	14 (1173A)	121	Solution of arsenious acid in water (without alcohol), food on an average over 7 per cent.	10	71	$\frac{1}{2}$	121
	(B.)	–	After 13 days food kept down to 3 per cent.	–	–		118
	15 (1174A)	113	Solution of ethylic alcohol in water after food; arsenic added after 19 days.	10	(71)	$\frac{1}{2}$	113
	(B.)	–	After 13 days food kept down to 3 per cent., arsenic added to the solution.	–	–	–	114
V.	16 (1179)	141	Solution of arsenious acid in water.	6	10,000	70	141
	17 (1175)	135	Solution of arsenious acid in water.	6	20,000	140	135
VI.	18 (1179A)	145	Arsenic free lager beer; bitter beer given on two occasions for short periods.	10	–	–	125
	19 (1179B)	159	Bitter beer with trace of arsenic. Lager beer given for short period.	10	under 1	under $\frac{1}{14}$	142

Experiments 12 and 13 on very young rats left out because these rats would not take the food and drink given to them.

TABLE II.

PERIODS of EQUAL DURATION in each SET.

Dry Food taken Daily per Cent. of Body Weight. (Grammes.)	Fluid *taken* Daily per Cent. of Body Weight. (c.c.)	Duration of Period.	Number of Days during which special fluid given.	Daily Dose of Arsenic. (Grammes.)	Daily Dose of Alcohol. (c.c.)	Weight of Rat at end of Period per Cent. of Original Weight. (Grammes.)	Daily Loss— or Gain+ (Grammes.)	Remarks about influence of Diet on Weight.
6	15·8	60	51	0·0000390	0·79	88	— 0·2	Amount of dry food sufficient to maintain weight and allow of some increase.
6·5	7·2	60	51	0·0000140	0	62·3	— 0·62	ditto - - ditto
5·8	7·8	60	51	0·0006000	0·30	62·7	— 0·62	ditto - - ditto
5·9	7·3	60	51	0·0007000	0	50	— 0·83	ditto - - ditto
6	16	60	—	0	0·80	92·2	— 0·13	ditto - - ditto (This animal was ill during the greater part of the experiment.)
10	8	39	30	0·0000008	0·8	104·5	+ 0·11	Amount of food sufficient to allow of an increase in weight.
10	7·6	36	27	0·0007600	0·76	67	— 0·90	ditto - - ditto
10	7·7	39	30	0·0007700	0	88·1	— 0·30	ditto - - ditto
4	8	59	65	0·0001055	0·48	55	— 0·76	Amount of food insufficient to maintain the weight.
4	8	60	39 beer - 21 water	Kd. [0·0001680]	0·40	88	— 0·20	ditto - - ditto
4	8	60	27 beer - 33 water	0	0·40	72·9	— 0·45	ditto - - ditto
7·3	10	20	20	0·0000710	0	97·3	— 0·13	Amount of food sufficient to allow increase in weight.
3	10	33	33	0.0000710	0	69·4	— 0·93	Amount of food insufficient.
7·3	10	20	20	0	0·5	100·8	+ 0·04	Amount of food sufficient.
3	10	33	33	0·0000710	0·5	84·2	— 0·47	Amount of food insufficient.
5	6	4	2	0·006	0	90·7	— 2·32	Amount of food just sufficient to maintain weight.
5	6	4	1	0·012	0	85	— 3·75	ditto - - ditto
8	10	51	51	0	0·5	110	+ 0·20	Amount of food sufficient to allow increase in weight.
8	10	51	51	0·0000010	0·6	74	— 0·43	ditto - - ditto

Appendix 17.

APPENDIX 17.

1900 EPIDEMIC AND 1901 BIRTH RATE.

MEMORANDUM sent to the Commission by Mr. *J. Niven*, M.A., M.B., Medical Officer of Health of Manchester, 11th July 1902.

ON THE APPARENT RELATION BETWEEN THE OUTBREAK OF ARSENICAL POISONING IN MANCHESTER IN THE YEAR 1900 AND THE DROP IN THE BIRTH RATE IN 1901.

The birth rate of Manchester for the year 1901 was 28·7 per 1,000, showing a decrease of 3·66 per 1,000 on the birth rate for the year 1900. So marked a decrease on the birth rate of a population of 546,000 persons seemed to require an explanation. Yet there appeared to be nothing in the state of trade to account for it, nor did the figures relating to pauperism indicate any marked increase of distress. There was, it is true, a slight decrease in the birth rate for the whole country in 1901 as compared with 1900 equal to 0·4 per 1,000, but the difference is so great as to show that what occurred in Manchester was not part of the general decline in the birth rate.

On reflecting over the more likely explanations it appeared to me to be possible that it was due to the outburst of arsenical poisoning in the year 1900. If this were so, a drop in the birth rate should also have occurred for Salford and Liverpool, both of which towns suffered considerably. The drop in Salford was found to be 4·2 per 1,000, in Liverpool 1·42 per 1,000.

The detailed figures are :—

BIRTH RATES, CORRECTED IN ACCORDANCE WITH THE CENSUS FIGURES.

	Manchester.	Salford.	Liverpool.
1898 - - -	32·70	34·9	33·21
1899 - - -	32·63	34·1	33·32
1900 - - -	32·38	33·3	33·45
1901 - - -	28·72	29·1	32·03

Now the outburst of poisoning was practically confined to the second half of 1900, and was much more severe in the fourth than in the third quarter. Hence the effect upon the birth rate should be most marked in the third quarter of 1901, though observable in the second and fourth ; in the fourth because the arsenical poisoning was not over in 1900, though its causes might be.

Such is in fact the case. The following are the recorded birth rates, in quarters, for the three towns, to which are added, for comparison, the corresponding birth rates for 1899 and 1900 :—

MANCHESTER BIRTH RATES, IN QUARTERS AS RECORDED.

	1899.	1900.	1901.
First quarter -	32·2	33·8	30·3
Second ,, -	33·9	33·0	28·9
Third ,, -	32·3	32·7	25·7
Fourth ,, -	30·8	28·4	29·8

SALFORD BIRTH RATES, IN QUARTERS AS RECORDED.

	1899.	1900.	1901.
First quarter -	33·8	35·3	31·2
Second ,, -	34·3	34·2	28·0
Third ,, -	33·5	32·1	25·8
Fourth ,, -	33·9	31·1	31·6

LIVERPOOL BIRTH RATES, IN QUARTERS AS RECORDED.

	1899.	1900.	1901.
First quarter -	35·3	38·4	36·2
Second ,, -	35·6	35·3	32·1
Third ,, -	35·9	36·2	31·2
Fourth ,, -	35·4	34·0	31·7

The anticipated differences in quarters is very well marked in Manchester and Salford, but in Liverpool the drop is more evenly distributed than in Manchester and Salford, though the distribution of the decrease is very much the same.

The same changes are not uniformly observed in smaller places visited by arsenical poisoning, but that is scarcely to be expected, as in a small place the workmen affected being few are more easily replaced.

Heywood was perhaps the district most severely visited along with Manchester and Salford, and here the birth rate was 3·2 per 1,000 less in 1901 than in 1900, while the greatest drop occurs in the third quarter.

Now, if the above be the true explanation of the drop in the birth rate, then—

(1.) On the removal of the disturbing cause, the birth rates should resume their previous amounts.

(2.) Other towns whether connected with Manchester and Liverpool or not, but free from arsenical poisoning, should not show corresponding changes in the birth rate.

(3.) The arsenical poisoning was due to the consumption of cheap beers, and we know generally the parts of the city where most of the mischief was done, which were generally the poorest parts. The decrease in the birth rate should be greatest in those parts of the city.

As regards the resumption of their former magnitude by the birth rates, these were in the first quarter of 1902 for—

Manchester.	Salford.	Liverpool.
34·6	35·2	35·6

To see whether a corresponding drop in the birth rate occurred in other towns, let us take the large towns connected with Manchester and Liverpool, namely,

Blackburn, Bolton, Preston, and Oldham, the first three of which were very little affected; inland seats of industry—Birmingham, Leeds, Sheffield, Nottingham, Leicester; seaports—Hull, London, Portsmouth, Cardiff.

If we record their birth rates in quarters we see that there is nothing corresponding to the depression of the birth rate in the third quarter of 1901 in Manchester, Salford, and Liverpool, except in Oldham.

It should be noted that the town populations on which each year's quarterly birth rates have been calculated are in each instance the "estimated populations" for the year, reckoned before the 1901 census figures were available.

If the object were to compare the annual birth rates of one town with another it would be needful to begin by making new estimates of the populations in the years in question, taking account of the 1901 census. But, for the purpose of studying the variations in the birth rate quarter by quarter in a given town, the more readily available "estimated population" for the year may be considered sufficient.

Appendix 17.

It will be seen that the quarterly birth rates in Oldham follow the same course in 1901 as do those of Manchester, Salford, and Liverpool. Now there was a certain amount of arsenical poisoning in Oldham though it is not believed to have been extensive. Whether the figures for Oldham are accidental, or indicate that there was more arsenical poisoning than was supposed, I have no means of saying.

London	30·8	29·6	28·6	28·4	1899
	30·4	28·7	28·6	26·6	1900
	29·5	28·8	28·9	28·0	1901
Portsmouth	27·0	25·9	26·4	25·3	1899
	27·9	26·4	24·2	24·3	1900
	26·8	27·1	28·2	27·9	1901
Cardiff	29·5	28·9	28·4	27·8	1899
	27·4	26·8	26·9	26·2	1900
	26·4	31·9	32·4	29·6	1901
Birmingham	34·9	25·5	34·0	32·8	1899
	34·9	34·0	32·6	29·4	1900
	32·6	32·2	32·2	31·2	1901
Leicester	29·1	31·1	28·8	28·7	1899
	28·8	29·2	29·1	25·7	1900
	27·6	30·9	28·1	28·0	1901
Nottingham	28·0	30·9	29·4	27·5	1899
	29·4	28·2	29·1	24·2	1900
	29·0	28·3	24·9	26·8	1901
Bolton	31·8	30·3	28·5	29·0	1899
	28·9	30·2	29·5	27·5	1900
	27·5	28·2	27·8	26·9	1901
Blackburn	28·6	27·1	26·9	25·5	1899
	27·2	26·2	25·3	22·0	1900
	24·7	28·5	26·5	24·3	1901
Leeds	29·7	32·1	30·6	30·0	1899
	30·7	30·7	31·2	29·2	1900
	28·7	30·9	30·0	30·0	1901
Sheffield	35·2	34·1	33·5	35·1	1899
	36·1	33·5	33·5	33·5	1900
	35·6	32·1	32·4	33·1	1901
Hull	33·4	35·1	34·6	33·7	1899
	35·0	31·8	33·7	31·0	1900
	33·7	33·1	34·0	32·1	1901
Newcastle	32·3	31·4	31·2	30·7	1899
	32·3	30·7	30·2	28·5	1900
	29·3	32·4	33·1	30·4	1901
Preston	30·8	30·9	30·0	28·5	1899
	32·0	29·6	28·3	26·0	1900
	31·8	32·2	30·1	27·6	1901
Oldham	25·2	24·9	24·1	25·1	1899
	24·4	23·4	24·7	24·0	1900
	25·6	23·9	22·6	26·4	1901

On the other hand, there is a tendency towards a minimum in the birth rate in the fourth quarter of the year in all these towns. It will be seen that the same tendency is observable in the birth rates for Manchester, Salford, and Liverpool. The relation in 1901 is therefore unusual, and the fact of its occurrence in all three towns is thus a striking one.

In not a single one of these towns was the difference between the highest quarterly birth rate and the birth rate in the third quarter in any of the three years nearly equal to the difference between the highest quarterly birth rate in 1901 and the birth rate in the third quarter of the same year in any one of the three towns, Manchester, Salford, or Liverpool.

The decrease of the birth rate in 1901 as compared with the mean birth rate for 1891–1900 in the three main divisions of the city of Manchester, and in each sanitary district of the city, also the relation to the birth rate in 1900, is shown in the following table:—

Appendix 17.

District.	Mean Birth Rate, 1891–1900.	Birth Rate, 1900.	Birth Rate, 1901.	Decrease or Increase in 1901 as compared with the Mean Birth Rate, 1891–1900.	Change in 1901 as compared with the Birth Rate, 1900.
City of Manchester	35·09	32·38	28·72	– 4·37	– 3·66
Manchester Township	35·51	33·84	29·08	– 6·43	– 5·46
Northern Districts	32·66	32·37	29·17	– 2·39	– 2·70
Southern Districts	32·39	31·57	27·86	– 4·51	– 3·71
Ancoats	37·98	36·38	31·75	– 6·23	– 5·13
Central	30·78	28·56	23·66	– 7·12	– 4·90
St. George's	36·35	34·29	29·79	– 6·56	– 4·50
Cheetham	31·72	31·28	31·55	– 0·17	+ 0·27
Crumpsall	24·68	24·20	24·40	– 0·28	+ 0·20
Blackley	27·17	25·48	24·56	– 2·61	– 0·92
Harpurhey	35·11	35·61	31·02	– 4·09	– 4·59
Moston	27·30	31·76	30·26	+ 2·96	– 1·50
Newton	30·59	29·10	25·84	– 4·75	– 3·26
Bradford	38·19	38·63	34·25	– 3·84	– 4·38
Beswick	37·97	38·72	32·52	– 5·45	– 6·20
Clayton	29·62	36·38	30·52	+ 0·90	– 5·86
Ardwick	34·72	35·96	30·88	– 3·84	– 5·08
Openshaw	36·18	35·88	31·18	– 5·00	– 4·70
West Gorton	36·25	36·73	29·67	– 6·58	– 7·06
Rusholme	25·73	25·69	30·86	+ 5·13	+ 5·17
Chorlton-on-Medlock	26·90	24·51	21·02	– 5·97	– 3·49
Hulme	34·65	33·40	28·84	– 5·81	– 4·56

On comparing these diminutions in the birth rate in 1901 with the figures for the death rate in union workhouses, we find that in the larger divisions of the city there is a correspondence between the magnitude of the diminution and the figure indicating poverty. This is not very close, however, for the individual districts.

On the other hand, all the individual districts in which the diminution is large are known to have been markedly affected by arsenical poisoning.

In Cheetham, the Jewish district, where there was very little arsenical poisoning, there is an increase in the birth rate.

In Rusholme, where there was but little, there is a marked increase. In the district of Moston also there was little or no arsenical poisoning.

The following districts we know to have been severely visited, viz., Ancoats, Central, St. George's, Harpurhey, Newton, Bradford, Beswick, Ardwick, Openshaw, West Gorton, Chorlton-on-Medlock, and Hulme.

So far then as these figures go, they support the view that the diminution of the birth rate in Manchester was due to the outburst of arsenical poisoning

J. NIVEN.

APPENDIX 18.

LIME FILTERS IN MALT KILNS.

MEMORANDUM RECEIVED FROM MR. E. S. BEAVEN, OF WARMINSTER, IN SUPPLEMENT TO HIS EVIDENCE ON JUNE 20th, 1902.

(Received June 23rd, 1903.)

In evidence before the Commission I stated that there were various methods by which the access of arsenic to malt with the furnace gases during drying might be prevented or reduced to negligible quantities. The methods which I stated to be practicable were :—

1. By reducing the velocity of the gases leaving the fire and by providing for a considerable proportion of the air to be heated before admixture with the furnace gases.
2. By treating the fuel with basic material with a view to fixation of arsenic in the furnace ash.
3. By cutting off the furnace gases when the fires are stirred.
4. By bringing the furnace gases into contact with basic material at a high temperature in an apparatus capable of being repeatedly cleansed.
5. By arresting furnace dust and uncondensed matter escaping the previous operations by means of curtains which, if so placed as to be kept below 350 F., act both as filters and as condensers of volatile matter.

I stated that I had used these methods as safeguards only, and with anthracite of good quality, and that I could not offer any evidence as to the application of the methods to other fuels, such as gas coke, which was not used for drying malt in the district with which I was acquainted.

The following questions were put to me :—

10813. Have you tried your lime filter with fuel containing larger quantities of arsenic ?—I have not, except absolutely experimentally, from which I have no results I can quote.

10814. Do you intend to continue your researches on the subject ?—I do.

10815. The Chairman will be grateful to you if you will communicate the results of further experiments, particularly with the object of finding out whether or not the distinctly arsenical fuel, fuel with more arsenic in it than that which we consider admissible, does give volatilised arsenic, which is removed by your process of a basic filter applied hot, or by condensation on the colder screens ?—I will do what is possible experimentally.

I accordingly obtained recently from the North of England Gas Coke in sufficient quantity for experiment.

I have forwarded to the Secretary a model of a malt kiln and furnace fitted with a basic filter similar to that in which the experiments to be described have been made.

The furnace itself is of a type common to many kilns, but the furnace gases, instead of passing directly, as is usual, into the distributing chamber, pass through a sloping grating which forms part of the structure of the furnace, and immediately come in contact with basic material. The basic material is arranged in a filtering chamber so as to be supported by this grating. The chamber is filled from above with irregular pieces of limestone to a depth of about 2 feet. The limestone immediately in contact with the grating is almost immediately converted into lime by the furnace gases, and from time to time some of the lime falls through the grating, and this is replaced from above with fresh material.

As compared with other malt kiln furnaces the volume and velocity of the furnace gases is much reduced, but their temperature is much higher than in the absence of the filter. The material in the lower part of the furnace is maintained at red heat, and the temperature, determined by a pyrometer, of the furnace gases leaving the filter usually exceeds 700 F. I have found no evidence of any re-volatilisation of arrested arsenic at the temperatures which are reached in the filter. As the temperature required for drying varies from 100 to 200 F. it is necessary and also economical to dilute the furnace gases with considerable volumes of cold air. This is taken up through channels surrounding the filtering chamber, and is indirectly heated in passing through these channels. In fact, with such arrangements or with modifications of them, it is obvious that by far the largest part of the air which is used is to some extent heated without contact with the fuel, and I find in practice that the consumption of fuel is less than in the same kilns without the filter.

The velocity and volume of the furnace gases passing through the filter have been repeatedly measured, and I find that a velocity of less than 50 feet per minute through the filter is quite sufficient where the superficial area of the filter is of suitable dimension.

The volume of air corresponding to this is more than sufficient for consumption of the fuel, and is very much less than the volume which usually passes through and over the fire in existing malt kilns.

The filtering material, in addition to arresting volatile arsenic, arrests in the lower strata particles of ash, invariably in my experience containing ferric oxide, and this dust at the temperature of the filter is capable, as I have already pointed out, of absorbing arsenic. I do not find that after some weeks of continuous use any sensible quantity of dust escapes from the filter, even when the material is not renewed, as it easily may be when necessary. I have, however, in all cases fitted above the filter dust arresting curtains of woven wire, provided with hanging gutters for receiving dust, and by these means the further passage of dust is prevented. A small quantity of volatile matter sometimes escapes complete arrest or combustion, both in the fire and in the filter, and this is condensed or collected upon the curtains.

Where coke is used which is considered to contain such quantity of arsenic as would be capable of showing an appreciable percentage in the malt, it is desirable, as an additional safeguard, to saturate it with lime water or thin milk of lime before burning. I find that to accomplish this it is necessary, not merely to put milk of lime or lime water over the fuel, but to immerse the coke in the fluid for about two hours. In this time the lime completely penetrates the coke. There is no doubt that this method fixes to some extent what might otherwise be volatile arsenic, but the fact that with the coke with which I have experimented there was, even after such liming of the fuel, some arsenic collected in the filter shows that with such cokes the filter is desirable.

Samples of a number of successive kiln loads of malt dried with the gas coke referred to have been examined and reported on to me as follows :—

No. 1.	Free, or below 1–700 gr. per lb. arsenic.	
No. 2.	do.	do.
No. 3.	About 1–500 gr. per lb. arsenic.	
No. 4.	Free, or below 1–700 gr. per lb. arsenic.	
No. 5.	do.	do.
No. 6.	do.	do.

The coke was reported to contain $\frac{2}{3}$ grain per lb. of arsenious oxide, and it is evident, therefore, that all but a very small fraction of the total quantity was either not volatilised or was arrested. I think it probable that even better results might, if necessary, be obtained by using more filtering material provided the structure of the kiln permits of a deeper filter being used without too greatly restricting the draught of the fire.

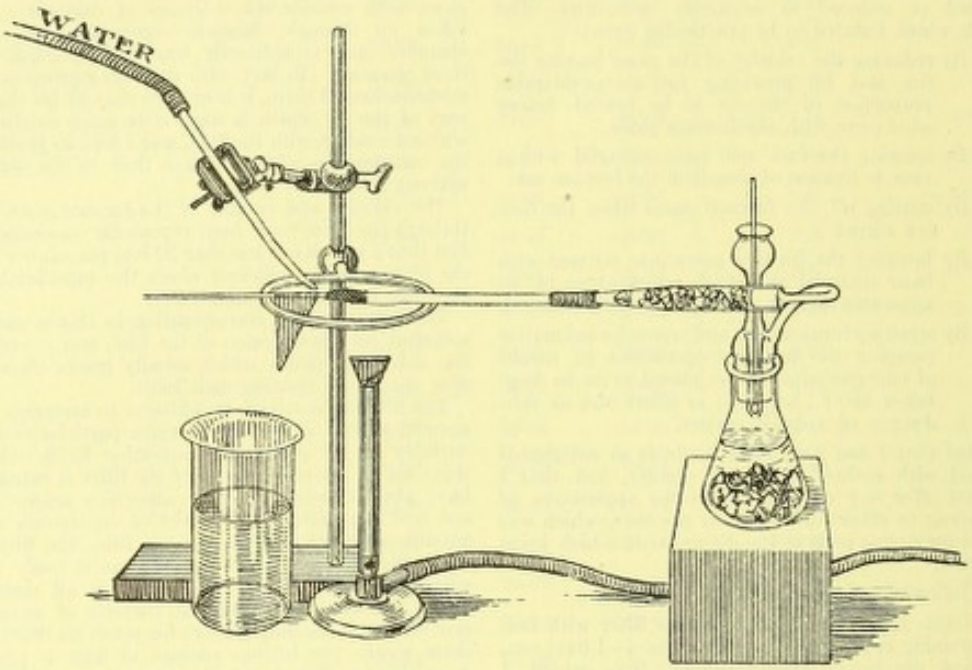
Samples corresponding to the above experiments are at the disposal of the Commission.

E. S. BEAVEN.

Appendix 18A.

APPENDIX No. 18A.

DIAGRAM in illustration of Mr. William Thomson's evidence. (Question 9688, p. 56.)



APPENDIX 19.

BREWERS' EXPERT COMMITTEE'S FINAL REPORT.

FINAL REPORT OF THE COMMISSION OF EXPERTS APPOINTED BY THE MANCHESTER BREWERS' ASSOCIATION.

Handed in by Mr. *Gordon Salamon*, 9th May, 1902.

To The Manchester Brewers' Central Association, Manchester.

Gentlemen,—The investigations rendered necessary by the results of the preliminary examination of brewing materials employed in Manchester and its district are now complete.

In all, 663 samples have been analysed for the purpose of the inquiry.

The effective manner in which the brewers carried out our previous recommendations speedily resulted in the beer brewed in Manchester being free from arsenic, and analyses of recent date clearly prove that Manchester beer is now fully as pure as any beer produced in the United Kingdom in respect of its freedom from even infinitesimal quantities of arsenic.

Preliminary Remarks.

The analyses and investigations that we have made prove finally and conclusively that the presence of arsenic in injurious quantities in the Manchester beer was in all cases due to the sugars manufactured by Messrs. Bostock and Co., Limited, and that such sugars derived their contamination exclusively from the employment in their manufacture of arsenicated sulphuric acid, supplied by Messrs. Nicholson and Co., Limited, of Leeds. No other cause of contamination to which the presence of arsenic in the observed quantities can be attributed has been discovered by us, nor is one believed to have been possible.

The first suspicion as to Bostock's sugar being the cause of the widespread poisoning dates from about the 21st November, 1900, and its employment in or about Manchester was discontinued by December 1st, 1900. Nevertheless arsenic continued to be found in smaller quantities in brewings both in Manchester and in many other parts of the United Kingdom. It was the discovery that such minute quantities of arsenic commonly existed in beer obtained from widely different sources that has necessitated the long and detailed investigations referred to in this Report, without which we have felt that we could not fulfil our task. For although these traces of arsenic in beer (of which the presence was hitherto quite unsuspected) cannot be said to be directly poisonous, and are, perhaps, not even injurious to the human system, it is extremely desirable that they should be eliminated if it be possible.

Analyses of Beers

One hundred and sixty samples of beer have been analysed by us for the purpose of this enquiry. These samples were collected from all parts of the country, between November 22nd, 1900, and the end of February, 1901, the larger proportion, however, being derived from Manchester and the surrounding district.

Of these 160 samples, 84 were found to be quite free from arsenic when examined by the Reinsch test. The remaining 76 samples were found to contain arsenic* in amounts ranging from one and 1-10th grain to 1-400th of a grain per gallon of beer.

Of the 76 samples found to contain arsenic, 53 were traced to have been brewed with Bostock's sugar, and represented brewings previous to December 1st, 1900. Of these 53 samples, 27 contained more than 1-20th of a grain of arsenic per gallon, a quantity which must be regarded as dangerous. Of these 53 samples, 37 were brewed in Manchester and district, and 16 were obtained from other parts of the country where Bostock's sugar had been used.

The remaining 23 samples, which were not brewed from Bostock's sugar, were found to contain quantities of arsenic ranging from 1-30th to 1-400th of a grain per gallon of beer. Of these, 21 contained less than 1-70th of a grain per gallon.

In our opinion these very small quantities were in every case derived from the malt. The sample containing approximately 1-30th grain per gallon was clearly proved to be an all malt beer. Such also was the case in respect of a sample containing approximately 1-70th grain per gallon.

It appeared, therefore, that (excluding those brewed from Bostock's sugar) 20·8 per cent. of the samples examined contained arsenic derived from sources independent of the special source of contamination to which the outbreak must be attributed. This result necessitated a searching examination of all materials employed in brewing, in order to ascertain definitely whether or not arsenic was to be found in them, which would account for the presence of these appreciable though small quantities in the beers.

We shall now proceed to give the results of this examination, arranging it for the sake of convenience under the headings of the materials examined.

Brewing Sugars.

One hundred and thirty samples of brewing sugars were analysed, made up as follows:—

Glucose	63
Invert Sugar	53
Raw and purified Sugar	11
Caramels	3
	130

Glucose.

Eight samples of glucose were proved to have been made by Messrs. Bostock and Co., Limited, and were probably delivered to breweries between September and November, 1900. All contained arsenic in quantities ranging from 0·027 per cent. to 0·075 per cent.

The remaining 55 samples were independently obtained from brewing sugar factories, merchants, agents, brokers, and breweries, and represented normal output and deliveries, both British and foreign, of all such goods employed in brewing in this country.

Of these 55 samples, five were ascertained to have been made by different makers previous to the contamination of Manchester beer by arsenic. They were found to be free from arsenic, with the exception of one which contained an infinitesimal quantity, approximately about 1-600th of a grain per lb.

The employment of even so large a proportion as 20 per cent. of this latter glucose for brewing purposes would have introduced an amount of arsenic into beer almost incapable of detection, and certainly negligible.

The remaining 50 samples were all found to be free from arsenic by the Reinsch test.

Invert Sugars.

Six samples were made by Messrs. Bostock and Co., Limited, and were probably delivered into breweries between September and November, 1900. These samples all contained arsenic, ranging in amounts from 0·021 per cent. to 0·067 per cent.

The remaining 47 samples represented every known manufacture, and were independently obtained as in the case of the samples of glucose.

Of these, five were ascertained to have been manufactured previous to the detection of arsenic by the Reinsch test.

Wherever the quantity of arsenic is referred to in this report it is estimated as arsenious oxide.

Appendix 19.

The remaining 42 samples were also found to be free from arsenic by the Reinsch test.

Raw and Purified Sugars used in Brewing.

These were all quite free from arsenic.

Caramels.

These were all quite free from arsenic.

Many other samples of caramel were analysed by some of the members of the Commission, independently of this investigation, and were found to be free from arsenic.

Malt Adjuncts.

Thirty-seven samples of malt adjuncts, *i.e.*, of different forms of starch to be used with malt in brewing, were submitted to analysis. As in the case of the brewing sugars these were independently obtained.

The samples were made up as follows:—

Rice—consisting of cleansed broken rice, cleansed whole rice, grits, flaked grits, flaked and gelatinised rice, all representing current deliveries to brewers - - - - - -	10
Maize—consisting of Danubian and American corn, flaked maize manufactured in England, American imported flaked maize, gelatinised maize and maize meal, also representing current deliveries to brewers - - - -	24
Sago Flour—taken at Messrs. Bostock's Works - - - - - - - - -	1
Tapioca Flour— ditto - ditto -	1
Torrefied Barley - - - - - -	1
	37

Not one of these samples revealed a trace of arsenic when examined by the Reinsch test, and there is nothing in their method of growth, composition, or mode of manufacture for brewing purposes, to suggest the possibility of arsenical contamination.

Hops.

Eleven typical samples representing English and foreign growths were submitted to analysis.

They were all found to be free from arsenic.

Nevertheless there exists the possibility of minute quantities of arsenic being present in hops, and we are aware that such traces have been found to exist in hops by analysts of authority. It is conceivable, but extremely improbable, that they are introduced with the sulphur employed when the hops are upon the poles, but they are much more likely to be derived from the fuel and brimstone employed for kilning operations in the Oast houses.

The quantity of arsenic thereby introduced into beer must in any case be infinitesimal.

Preservatives, Water Hardening Materials, Etc.

Sixteen samples, independently collected and representing materials in current use, were submitted to analysis.

Of these, five were found to contain arsenic. Four of them respectively contained arsenic approximately amounting to 1-300th 1-300th, 1-700th, and 1-200th grains per pound of material.

The quantity of material used per barrel of beer being in all cases extremely small, the arsenic introduced into beer from such sources would be infinitesimal.

The fifth sample above referred to contained approximately 3-5ths of a grain of arsenic per pound of material. The amount present distinctly showed gross negligence in manufacture, but the proportion of the preservative in question employed in brewing is so small per barrel that the amount of arsenic introduced into beer by its use would also be infinitesimal. We believe that this material is not in use in Manchester or the surrounding district.

Eleven samples were quite free from arsenic

Finings.

Six samples as used for clarifying beer throughout the country were submitted to analysis. They were all found to be free from arsenic.

Yeast.

Nineteen samples of yeast produced in Manchester breweries, at or about the time of the outbreak, were submitted to analysis.

Of these, 10 contained arsenic in quantity ranging approximately from $\frac{1}{4}$th grain to 1-200th grain per pound of pressed yeast.

Analyses made during February last proved that the Manchester yeast had been freed from arsenic, and may to-day be regarded as quite pure. This statement applies even to those breweries in Manchester in which Bostock's sugars had previously been employed.

The extremely interesting discovery has been made that if arsenic be present in worts, yeast will take up a very considerable proportion of it. It would be rash to hazard the prediction as to whether this is due to mere mechanical absorption, or to any physiological or chemico-physiological action as between the arsenic and the yeast. The fact remains, however, that in a brewery in which only minute quantities of arsenic are to be found in the brewing materials, much more definite quantities of arsenic are to be found in the yeast.

Barley.

Fourteen samples of typical malting barley, grown in different parts of the country, were submitted to analysis. In every case 50 grammes of material was operated upon.

Five samples out of the 14 contained minute quantities of arsenic.

One sample of unkilned barley contained approximately 1-400th grain of arsenic per pound.

A sample of Lincolnshire barley, certified as non-kiln dried, was submitted to analysis and found to be free from arsenic.

The same barley after kiln drying, *i.e.*, previous to malting, was found to yield a very distinct mirror of arsenic by the Marsh test, and to contain approximately 1-200th of a grain of arsenic per pound. In this case the slight contamination of the barley had been undoubtedly derived from the fuel used for kiln drying.

Another sample of barley not previously kiln-dried yielded a very minute mirror of arsenic by the Marsh test, as well as distinct evidence of the presence of arsenic by the Reinsch test. It contained approximately 1-700th of a grain of arsenic per pound. This same specimen of barley was afterwards kiln-dried, and upon examination was found to contain approximately 1-400th of a grain of arsenic per pound.

The above two sets of analyses are instructive, as showing the proportion of arsenical contamination which can be derived from the kiln drying of barley.

One of the samples above referred to, namely, that which yielded approximately 1-200th of a grain of arsenic per pound, was steeped in cold water for sixty hours, and again tested. The mirror obtained was distinctly smaller, and the amount of arsenic was estimated at approximately 1-250th grain of arsenic per pound.

The remaining 10 samples were quite free from arsenic.

The question of the source of the contamination of barley before it had been subjected to any manufacturing process naturally presented itself, and accordingly two samples of super-phosphate manure employed for root crop growth were examined. They were furnished by one of the members of your Association. One of these samples contained a mere trace of arsenic. The other sample was heavily charged with arsenic.

A sample of urine, obtained from a ewe, one of several that had died after feeding off roots grown on land manured with these super-phosphates, was also furnished for examination. It was found to contain a small amount of arsenic, but the quantity operated upon was of necessity very small, and no quantitative estimation was possible.

From these results there can be no doubt that barley is liable to take up very minute quantities of arsenic when grown upon land manured with arsenicated fertilisers.

Malts.

One hundred and thirty-eight samples of malt, fairly representing the malt made and used throughout the country, were obtained from independent sources, and submitted to analysis.

Of these one sample contained approximately 1-39th gram of arsenic per pound.

Six contained approximately 1-50th of a grain of arsenic per pound.

One contained approximately 1-80th of a grain of arsenic per pound.

The remainder contained from 1-100th to 1-300th of a grain of arsenic per pound.

Ninety-seven samples were found free from arsenic by the Reinsch test.

Those samples which contained arsenic were mainly derived from maltings situated in the Midlands and the Northern Counties. The products of the Southern and Eastern Counties exhibited remarkable freedom from arsenic.

The malt containing these traces of arsenic when brewed would, in all probability, impart only a minute quantity of arsenic to the beer, having regard to the removal of arsenic effected by yeast; and it is probable that such traces have existed for many years past. There can, however, be no doubt that it is quite practicable wholly to avoid this contamination, and no better evidence could be given in support of this statement than by reference to the malts supplied to-day to the breweries in and around Manchester, which are remarkably free from arsenic.

The importance of thoroughly examining this arsenical contamination of malt led us to examine two products of the malting process not used in brewing, viz., malt-culms, and kiln dust, as well as the coal and coke used in malting.

Malt-culms.

Forty samples were submitted to analysis, 50 grammes being in each case operated upon.

Of these, 24 were found to contain arsenic. Of these, seven approximately contained at least one grain of arsenic to the pound. The remainder varied from this quantity to 1-300th of a grain to the pound.

It was noticeable as in the case of the malts that the great majority of the samples of culms containing arsenic (and particularly of those containing large amounts) were obtained from maltings in the Midlands and the Northern Counties. The Southern and Eastern Counties' culms were particularly free from arsenic. But cases occurred where the malt had been free from arsenic but the culms from the same maltings were contaminated. It was evident, therefore, that this contamination affected culms to a much greater degree than the malt itself.

Kiln Dust.

Twenty samples obtained from maltings from which malt and culms had been furnished were submitted to analysis.

Of these, 18 contained arsenic.

Of these, seven contained approximately between one and two grains of arsenic per pound.

The remainder contained arsenic in quantities diminishing to 1-300th of a grain per pound.

It is to be noted that in the case of kiln dust coming from maltings where the culms were free from arsenic, the kiln dust contained it in nearly every case, and the large quantities of arsenic above alluded to were in every case derived from those maltings which had yielded arsenic-loaded culms. It is therefore apparent that the kiln dust contains more arsenic than culms, and the culms vastly more than the malt.

It should not be forgotten in connection with the desirability of preventing the presence of arsenic in malt and its bye-products, that the culms are largely used for feeding purposes, and are given to sheep and stock as they are produced. Their price has averaged for the last three years about 65s. per ton. They are worth between 70s. and 80s. per ton at the maltings in the winter season, and drop to 50s. or 60s. per ton in the spring.

Malting Coal.

Nineteen samples of malt anthracite, independently obtained from various maltings throughout the country, were submitted to analysis.

Of these, two only contained arsenic in minute traces. The others were free from arsenic.

Coke.

Twelve samples of coke independently obtained and used in maltings in different parts of the country were submitted to analysis. Of these ten contained notable quantities of arsenic, and two were free from arsenic. Of the latter, one came from Scotland, and the other from Yorkshire. The contaminated samples of coke included both gas coke and oven coke.

The amount of arsenic present in these samples of coke was amply sufficient to account for the observations made in respect of the arsenical contamination of the kiln dust, the culms, and the malt above alluded to.

Cask Shavings.

In order to test whether contamination by arsenic could be imparted to beer by the use of casks which had previously been used for arsenicated beer, we thought it advisable to examine some cask shavings.

Eleven samples taken from casks known to have contained highly contaminated beer were submitted to analysis. They were all found to be free from arsenic.

Proof was thus furnished that the washing to which the casks had been subjected had effectually removed all contamination, and that there was no retention of arsenic by the wood. The shavings were from the interior surface of the cask, and were also deeply cut from beneath the interior surface.

Summing up the above results, it is clear that the most frequent source of arsenical contamination in beer is the use of malt which has been kiln-dried or malted with improper fuel containing arsenic. At the same time the experience of the late outbreak has shown that precautions must be taken against the presence of arsenic in brewing sugars and other materials (except perhaps malt adjuncts) on account of the serious consequences of any carelessness in manufacture which might introduce arsenic. Accordingly we have considered what steps should in future be taken by brewers to protect themselves from any repetition of the recent disasters.

RECOMMENDATIONS.

We recommend that brewers should make it a rule to require a written guarantee of freedom from arsenic with all purchases of brewing materials of every kind.

In addition to this we recommend that brewers should from time to time test the purity of their beer in respect of arsenic. The fact that yeast has a special affinity for arsenic affords an excellent method of demonstrating the purity of the materials used. If the yeast be tested for arsenic, it will readily show whether the wort is contaminated, for it will be many times richer in arsenic than the wort itself. It thus forms an excellent indicator of the presence of arsenic.

In addition to frequent testing of the yeast, it would be advisable for the brewers to take control tests from time to time of their brewing sugars, finings, and other materials. But in addition to these tests, and of the general guarantee above referred to, we recommend that in the case of brewing sugars, malt and hops, special guarantees should be required as follows:—

Brewing Sugars.

Brewers should demand from the manufacturers—

(1) A written guarantee that the brewing sugar is free from arsenic, and that a bulk sample representing each specific delivery has been analysed and certified by a competent analyst to be pure and to contain no trace of poisonous metal.

(2) The acid employed, whether sulphuric acid made from brimstone or pyrites, or hydrochloric acid as the case may be, should be guaranteed by the manufacturer to be free from all arsenic. The brewer should exact the production of such guarantee by the brewing sugar manufacturer at his demand.

(3) The manufacturer of brewing sugar should undertake, notwithstanding such guarantee, to have each delivery of such acid suitably tested at his own works by a competent analyst for the presence of arsenic.

(4) If yeast be employed, as it occasionally is, for the purpose of inverting cane sugar, it should, on account of its peculiar liability to absorb arsenic, be tested for this metal previous to use.

Appendix 19.

(5) As an additional safeguard, brewers would do well to insist upon a minimum Brewer's Extract for invert sugars of 72 lbs. per 2 cwt., and a maximum amount of mineral matter not exceeding 2 per cent. upon the total composition of the invert sugar.

Notwithstanding the absence of arsenic in the samples of caramel which have been examined by us, it cannot be denied that the method of manufacture of caramel, and the fact that it is employed for imparting colour to beer (as well as spirits, sauces, and many other food stuffs), admits of the possibility, although remote, of the introduction of arsenic in very small quantities into beer, and therefore although the amount of arsenic that could be so introduced would be infinitesimal, the brewer is recommended to obtain from the manufacturer a guarantee that the caramel has been tested and found to be free from arsenic.

Hops.

The brewer should demand that the hop merchant should obtain from the factor, who in turn would obtain it from the grower, a guarantee that none but the purest "flowers" were used upon the poles, and that the fuel and brimstone employed for drying were free from arsenic.

Malt.

It has been mentioned that when malt is contaminated with arsenic the malt culms and kiln dust contain a much larger proportion of arsenic than the malt itself. This is accounted for by the fact that when the green malt is loaded on to the kiln, and subsequently during the kilning, the physical structure of the culms renders them particularly liable to absorb any arsenious vapour that may be carried through the malt as the result of combustion of contaminated fuel, and that this liability is increased by the fact that from their position relative to the malt they are more exposed to the heated air.

The importance of this is shown by the fact that although the proportion by weight of culms to malt is only about 2 per cent., yet the amount of arsenic contained in the culms is vastly in excess of that to be found in the malt.

The same remark applies with greater emphasis to the kiln dust, which is produced to an extent varying from a little over half per cent. up to nearly 2 per cent. by weight of the malt. It is, however, not used as cattle food, but is sold as manure (principally for root crops), and fetches between 30s. and 40s. per ton at the maltings.

Our investigations have shown that the contamination of malt culms and kiln dust is chiefly due to the use of coke, and especially of gas coke.

Enquiries made of the principal maltsters in England have elicited the practically unanimous opinion that there is no necessity whatever to employ gas coke in the preparation of malt. Nor, indeed, is there any real necessity to employ coke at all for purposes of malting.

If the use of coke were dispensed with a good many malt kilns would have to be structurally modified, but the brewer would not fail to appreciate the benefit of such alterations.

The price of good malting anthracite has recently advanced, and may be taken to range this season from 32s. to 36s. per ton delivered at the maltings.

Gas coke varies from 18s. to 20s. per ton, and contract prices are lower than this.

This price does not in all cases include carriage to the maltings.

Washed coke is about 38s. per ton, but the price varies considerably.

When coke is used it is usual to employ all coal for the first two days, a mixture of two-thirds coal and one-third coke on the following day, and half coal and half coke on the finishing day. The object is stated to be to secure higher temperatures. The prices quoted in respect of gas coke, however, show that there is another object for its employment, and it is to be observed that it is mainly maltsters for sale that largely use gas coke.

It might be necessary to use a small proportion of coke in the drying of amber malt, but in such case it would certainly be advisable to employ coke made from hand picked and washed coal, and not gas coke.

We recommend therefore—

(1) That the maltster be required to give a guarantee to the brewer that he does not employ gas coke in the preparation of his malt.

(2) That the malt culms be regularly tested for the presence of arsenic.

(3) If the culms be found to contain noticeable quantities of arsenic, that the kiln dust be at once removed, and the fuel employed be further examined for arsenic.

(4) That wherever possible, the best anthracite be employed for malting purposes.

Selenium.

The contaminated sugars supplied by Messrs. Bostock, as well as the contaminated acid used by them, have been tested by Dr. Stevenson, Mr. Gordon Salamon, and Dr. Luff, to ascertain whether selenium was present, but they have found none.

The Testing of Beer for Arsenic.

We have now examined all the possible sources of arsenic in beer, and have pointed out the precautions necessary in each case. If such precautions be taken we believe that the beer will be brewed free from arsenic, and at no substantial increase of cost. And in view of the desire of the brewers that the beer supplied to the public should be free from all suspicion of containing arsenic, we recommend that the following should in future be adopted as the standard test and should be regularly applied. It is more stringent than the one recommended in our former report, but it is not too delicate for the standard of purity to which, in our opinion, the beer should attain.

This test (Reinsch) should be performed as follows:—

Take 200 c.c. of the beer in a porcelain evaporating dish, acidulate with 1 c.c. of pure concentrated hydrochloric acid, and evaporate till the volume of liquid is reduced to one-half. Then add a further 15 c.c. of the hydrochloric acid, and insert a piece of pure burnished copper foil, a quarter of an inch by half an inch in size, and keep the solution gently simmering for an hour, replacing the evaporated liquor from time to time by distilled water. If at the end of an hour the copper remains bright and red, the beer is arsenic-free.

If a deposit is obtained on the copper, the foil should be removed, washed successively with water, alcohol, and ether, dried at a temperature not exceeding 100° C., and subjected to slow sublimation in a thin reduction tube, not less than two inches long and having an internal diameter of 0·15 inch, the upper portion of which should be warmed before the sublimation begins. For the purpose of the sublimation a small spirit lamp flame should be used. If any sublimate is obtained, it must be examined under a magnifying power of about 200 diameters. Any sublimate which does not show well-marked octahedral or tetrahedral crystals is not to be considered arsenical. Mere blackening of the copper, or deposit thereon, does not demonstrate the presence of arsenic.

The addition of oxidising agents to decompose sulphites, and the use of reducing agents to decompose possible arsenates, is not recommended, as such a procedure is, in our opinion, unnecessary in the testing of beer, and introduces sources of error.

In all cases where the presence of arsenic is ascertained by this test, it is then desirable to estimate the amount by means of the Marsh test, which, although not giving an accurate quantitative determination, will, when properly applied, give an approximate estimation of the amount of arsenic present.

When arsenic is detected by the above test its quantity is best determined by the process of Marsh (Marsh-Berzelius), which should be performed as follows:—

The beer—preferably 50 c.c.—is acidulated by the addition of 1 c.c. of pure concentrated hydrochloric acid, and gently boiled in a porcelain evaporating dish for a few minutes till frothing nearly ceases, cooled, and gradually introduced into a Marsh apparatus of 200 c.c. capacity, which is already giving off a gentle stream of pure hydrogen gas, evolved from pure zinc and diluted hydrochloric acid. The purity of the evolved gas is first tested by ascertaining that it yields no mirror after

15 minutes, when it has been passed through a drying tube charged with successive layers of cotton wool, lead carbonate, and spongy calcium chloride, and then heated to dull redness in a narrow glass tube drawn out to a capillary size just beyond the point of heating The open point of the tube at which the gas escapes should be turned upwards at right angles, so that the amount of issuing gas can be regulated by seeing that when lighted the flame of the burning gas is just perceptible. The beer is introduced by means of a straight thistle funnel provided with a stop-cock, so that the admission of liquid into the apparatus can be regulated without introducing air. From time to time a little pure concentrated hydrochloric acid is also introduced, so as to maintain the uniform evolution of gas.

The blank experiment having shown no mirror in the heated tube at the end of 15 minutes, the experiment is continued for half an hour after the commencement of the introduction of the beer. The arsenical mirror thus obtained is then compared with standard mirrors obtained by treating known quantities of arsenious oxide dissolved in water with the addition of pure hydrochloric acid under precisely similar conditions as to generation of gas, and the quantity of arsenic present is thus judged with great approximate accuracy. The mirror may subsequently be converted into crystals of arsenious oxide by sealing off the portion of the tube containing the mirror at each end by means of a blowpipe, and then gently heating the tube, by which means the mirror is volatilised, oxidised, and converted into crystals of the oxide. The mirrors obtained should be small, the comparison of small mirrors yielding more accurate results than where large mirrors are compared. Appendix 19.

We believe that if the recommendations contained in this report are carried out the brewer will send out beer free from arsenic, and the public health will be amply safeguarded.

(Signed) *Lauder Brunton.*
Thos. Stevenson.
Alfred Gordon Salamon.
Arthur P. Luff.
Samuel Buckley.
J. Fletcher Moulton.

May 11th, 1901.

APPENDIX 20.

"JOINT COMMITTEE'S" REPORT.

REPORT OF THE JOINT COMMITTEE OF SOCIETIES OF CHEMICAL INDUSTRY AND PUBLIC ANALYSTS ON THE DETECTION AND APPROXIMATE ESTIMATION OF MINUTE QUANTITIES OF ARSENIC IN BEER, BREWING MATERIALS, FOOD-STUFFS, AND FUELS.

Handed in by Mr. Otto Hehner and Mr. Chapman, 13 June, 1902.

The joint committee of the Society of Chemical Industry, and of the Society of Public Analysts, appointed in March, 1901, and consisting of Messrs. Otto Hehner (chairman), Alfred H. Allen, Alfred C. Chapman, C. Estcourt, David Howard, Arthur R. Ling,* Drs. Rudolph Messel, and Leonard T. Thorne, reports as follows:—

After an examination of various methods, the committee recommend that of Marsh-Berzelius.

Materials Required.

Hydrochloric Acid.—The purest hydrochloric acid obtainable is very rarely free from arsenic. To the "pure" acid, as purchased for analysis, diluted with distilled water to a specific gravity of 1·10, sufficient bromine is added to colour it strongly yellow (about 5 c.c. per litre); sulphurous acid, either gaseous or in aqueous solution, is then added *in excess*, and the mixture is allowed to stand for at least twelve hours. Or hydrobromic acid and sulphurous acid may be used. The acid is then boiled till about one-fifth has evaporated, and the residue can either be used direct, or may be distilled, the whole of the arsenic having volatilised with the first portion.

Sulphuric Acid.—This is more frequently obtainable arsenic-free than hydrochloric acid. If not procurable, to about half a litre of sulphuric acid, "pure for analysis," a few grammes of sodium chloride are added and the mixture distilled from a non-tubulated glass retort, the first portion of about 50 c.c. being rejected. For the purpose of the test to be described, one volume of the distilled acid is diluted with four volumes of water.†

Nitric acid can, as a rule, be obtained free from arsenic without much difficulty, the pure redistilled acid being used. This should be tested by evaporating 20 c.c. in a porcelain dish, which should then be washed out with dilute acid, and tested as described in this report.

The purified acids should be prepared as required, and should not be stored for any length of time. If this be unavoidable, however, Jena flasks are to be preferred, since most bottle glass is liable to communicate traces or arsenic.

Zinc.—Arsenic-free zinc is obtainable from chemical dealers. It should be regranulated by melting it and pouring it from some height into cold water.†

Lime.—Caustic lime, even when made from marble, is not always free from arsenic. A selection must, therefore, be made from various samples. If pure lime is not obtainable, magnesia may equally well be used, and can more readily be obtained of sufficient purity.

Calcium Chloride.—This salt often contains arsenic, and before being used as a drying agent must be freed from the volatilisable part of the impurity by moistening it with strong hydrochloric acid, fusing, and regranulating.

Apparatus.

A bottle or flask, holding about 200 c.c. (for frothing materials preferably wider at top than bottom), is fitted with a doubly-bored cork, india-rubber stopper or with a ground-in glass connection, carrying a tapped funnel holding about 50 c.c. and an exit tube. The latter is connected with a drying tube containing, first, a roll of blotting paper soaked in lead acetate solution and dried, or a layer of cotton wool prepared in a similar way, then a wad of cotton-wool, then a layer of granulated calcium chloride, and finally a thick wad of cotton-wool. To this tube is fitted a hard glass tube, drawn out as shown in the figure, and of such external diameter that at the place where the arsenic-mirror is to be expected the tube just passes through a No. 13 Birmingham wire gauge (corresponding with 0·092 inch). The exact size is not material, but all tubes used for standards and tests should be as nearly as practicable of the same diameter. A good Bunsen flame is used to heat the hard glass tube close to the constriction. About one inch of tube, including the shoulder, ought to be red-hot. A piece of moderately fine copper gauze (about one inch square) wrapped round the portion of the tube to be heated assists in insuring an equal distribution heat.‡

Mode of Testing.

About 20 grammes of zinc are placed in the bottle, and washed with water to clean the surface, as particles of dust may contain arsenic; all parts of the apparatus are connected, and a sufficient quantity of acid (prepared as previously described) allowed to flow from the funnel, so as to cause a fairly brisk evolution of hydrogen. When the hydrogen flame—which during the heating of the tube should be kept at as uniform a height as possible (about a quarter of an inch)—burns with a round, not pointed tip, all air has been removed from the apparatus. The Bunsen burner should then be placed under the hard glass tube as described, and more acid (10 to 20 c.c. is generally enough) run in as required. With good materials no trace of a mirror is obtained within half an hour. Great care must be taken that when additions of acid are made to the zinc no bubble of air is introduced, since in presence of air the arsenic mirror may become black and unevenly distributed, whilst it is brown when the experiment has been properly conducted.

Should the blank experiment not be satisfactory it must be ascertained by changing the materials methodically, whether the fault lies with the acid, zinc, other materials, or with the apparatus.

Preparation of Standard Mirrors.—When a satisfactory blank experiment has been obtained a series of standard mirrors must be prepared under the following conditions:—

A hydrochloric acid solution of arsenious oxide, containing in each cubic centimetre 0·001 milligramme As_4O_6, is prepared by diluting a stronger solution with distilled water. Two c.c. of this solution (equal to 0·002 milligramme of arsenious oxide) are introduced into the apparatus, a new tube having been joined to the drying tube. If the zinc is sensitive, a distinct brown mirror is obtained after twenty minutes. It is important to note that some "pure" zinc is, from a cause at present unknown, not sufficiently sensitive; that is to say, the addition of minute quantities of arsenic produces no mirror. The portion of the tube containing the mirror should be sealed off while still filled with hydrogen; in contact with air the mirrors gradually fade. Mirrors are now similarly made with 0·004, 0·006, 0·008, and 0·01 milligramme of arsenious oxide. With a little practice it is easy to obtain the deposits of arsenic neatly and equally distributed. The standard mirrors, properly marked,

* Mr. Ling also acted as secretary.

† Mr. A. H. Allen holds it to be essential, both for a regular evolution of hydrogen and for the formation of uniformly deposited brown-coloured mirrors, that the zinc should contain a trace of iron

‡ A diagram of a suitable form of apparatus is given in "*The Analyst*," February, 1902

are mounted on a white card or porcelain slip. It is to be understood that the first stage of every test must be a blank of at least twenty minutes.

Hydrochloric acid is somewhat more sensitive than sulphuric acid—that is to say, it gives rather denser mirrors with minute quantities of arsenic. If, for one reason or another, sulphuric acid is preferred by the operator, he must make a set of standard mirrors with sulphuric acid, and use these for comparison.

Organic materials, such as beer, yeast, etc., cannot be tested, when sulphuric acid is used, without destruction of the organic matter, whilst, as a rule, they can be directly tested with hydrochloric acid. However, many materials are met with in which it is preferable to destroy the organic matter.

PROCEDURE WITHOUT DESTRUCTION OF ORGANIC MATTER.

The apparatus is started, and a blank experiment allowed to go on for twenty minutes. If no trace of a deposit is obtained, 10 c.c. of the liquid to be tested and about 10 c.c. of hydrochloric acid are put into the funnel, and slowly introduced into the bottle without air-bubbles. Some materials (beers, for example) are apt to froth, hence the necessity for slow introduction. If after about ten minutes no mirror appears, another 10 c.c. of the liquid, with 10 c.c. of hydrochloric acid, are added, and the experiment continued for fifteen to twenty minutes, acid being from time to time added as may appear necessary.

Malt.—Fifty grammes of the malt are placed in a 500 c.c. separator funnel furnished with a stopcock; 150 c.c. of hydrochloric acid, prepared as described, and 50 c.c. of water are warmed to about 50° C., and poured on the malt. The whole is then allowed to digest for fifteen to twenty minutes, with frequent agitation, and the acid then allowed to run off by the stopcock. About 60 c.c. of the acid liquor is thus obtained, of which every 20 c.c. contains the arsenic from 10 grammes of the malt.

Hops.—Twenty grammes of hops are digested with 200 c.c. of dilute hydrochloric acid (one volume of the purified acid to one volume of water) at about 50° C. for half an hour, 50 c.c. of the strained-off liquid being used for the test.

Sugar and other *brewing materials* are dissolved in water, 10 c.c. of acid added, and the solution tested direct, operating upon from 10 to 20 grammes of material.

DESTRUCTION OF ORGANIC MATTER.

(a) *Acid Method.*—Ten grammes of the substance are placed in a 3½-inch porcelain crucible, and covered with pure redistilled nitric acid (about 10 to 15 c.c.). The whole is then heated on a sand-bath until the evolution of brown fumes ceases. Three c.c. of concentrated arsenic-free sulphuric acid are then added, and the heating continued till the mass just begins to char, when a further quantity of 5 c.c. of nitric acid is added. The heating is now continued till all the acid is expelled, leaving in the crucible a black, nearly dry, charred mass. The crucible is about half filled with water and a few c.c. of hydrochloric acid, or of dilute sulphuric acid, run in (according as the one or the other is to be used in the Marsh apparatus), the whole being allowed to extract for about half an hour on a water-bath. It is then filtered into a porcelain basin, the charred mass washed with hot water, and the filtrate concentrated down to about 5 c.c., which is allowed to cool, and is then ready for the test. It is essential that the mass should be *thoroughly* charred, and that the solution, when filtered, should be colourless.

In the case of *beer*, 10 to 20 c.c. are evaporated to dryness on a water-bath, and the residue oxidized as above stated.

Hops.—10 c.c. of pure nitric acid and 5 c.c. of pure concentrated sulphuric acid are mixed in a 3½-inch porcelain crucible, and the hops are then added in small portions at a time, each quantity being thoroughly disintegrated by pressure under the acid with a glass rod, a further quantity of 5 c.c. of nitric acid being added when about half the hops have been thus introduced. The crucible with its contents is then cautiously warmed so as to avoid frothing over. When the evolution of dense red fumes ceases the heating is increased, and the acids are evaporated on a sand-bath, and the dry charred mass extracted with dilute acid, filtered, concentrated, and introduced into the Marsh apparatus in the ordinary way. It may be noted that with many English hops of relatively fine texture the addition of the second quantity of nitric acid above recommended is unnecessary.

When, owing to the presence of larger quantities of arsenic, smaller amounts of substance—*e.g.*, 0·5 gramme to 2 grammes—are taken, the quantities of acids recommended above may, of course, be reduced.

(b) *Basic Method.*—The materials are mixed with pure lime or magnesia (1 gramme for 20 c.c. of beer), dried and incinerated. For sugars or other solid materials about half their weight of base is employed. The ash is dissolved in hydrochloric acid, and the solution tested. This method is not recommended for hops.

Of *coal* or other *fuel*, after careful sampling, two portions of 1 gramme each are weighed. One portion is incinerated in a platinum dish in a muffle, and the hydrochloric acid extract of the ash tested for "non-volatile arsenic." The other is intimately mixed with 1 gramme of lime or magnesia and also incinerated. The hydrochloric acid extract of the latter gives the "total arsenic," the difference between the two determinations being the "volatile arsenic." It may in some cases be found that the above-mentioned quantity of fuel gives a mirror too dense to be measured. When this is the case the hydrochloric acid extract is diluted to a determinate volume and an aliquot portion taken.

Sulphites.—The sulphurous acid must be oxidized by bromine, the excess of the latter being removed by heating.

The committee have convinced themselves that arsenic in both states of oxidation can be detected and estimated by the procedure described.

As an additional precaution a fresh tube should always be substituted for that containing the mirror, and the experiment continued for a further period of 15 minutes. Should a second mirror be formed, the quantity of arsenic with which it corresponds is to be added to that shown by the first.

It must be understood that the tests are only approximate, and that mirrors corresponding with less than 0·003 milligramme of arsenious oxide in the quantity of materials taken cannot be safely relied upon. When a mirror has been obtained, a duplicate test should always be made to preclude error by accidental contamination.

The proof that the mirrors are arsenical is obtained as follows:—The narrow portion of the tube containing the mirror (which should not be denser than that produced by 0·01 milligramme of arsenious oxide) is cut off, the hydrogen replaced by air, and the ends sealed up. The tube, held in the tongs, is then heated by drawing it repeatedly through the flame of a Bunsen lamp until the mirror has disappeared. On cooling, minute crystals of arsenious oxide deposit, the sparkling of which can be seen with the naked eye, if the tube be held before a luminous flame, and which can be readily identified under the microscope by their crystalline form.

This test, as recommended, is one of such extreme delicacy, that with quantities of 20 grammes (or 20 c.c.) it will give an indication of the presence of 0·000015 per cent. (or one part in 7,000,000) of arsenious oxide. This would represent with solids $\frac{1}{700}$ grain per pound with liquids $\frac{1}{50}$ grain per gallon. It must be understood that the committee do not suggest any limits for traces of arsenic which may be regarded as negligible; but they desire to express the opinion that limits should officially be fixed by the Royal Commission or otherwise. This could be easily effected by prescribing the amounts of solids and liquids respectively to be taken for the test, and the minimum mirror to be recognised.

APPENDIX 21.

REPORT OF THE INLAND REVENUE DEPARTMENTAL COMMITTEE.

HANDED in by SIR HENRY PRIMROSE, April 3, 1903.

REPORT OF THE COMMITTEE APPOINTED BY THE COMMISSIONERS OF INLAND REVENUE TO SPECIFY THE INGREDIENTS OF BEER, AND THE MATERIALS USED IN THEIR PREPARATION WHICH ARE LIABLE TO BE CONTAMINATED BY ARSENIC, AND TO PRESCRIBE TESTS BY WHICH THEIR FREEDOM FROM ARSENIC MAY BE ASCERTAINED.

To the Honourable the Commissioners of Inland Revenue.

Gentlemen,—The Committee charged by the Board of Inland Revenue—in conformity with the recommendation of the Royal Commission appointed to inquire into Arsenical Poisoning from the consumption of Beer—to specify in detail individual ingredients of beer which are liable from their origin or mode of preparation to be contaminated by arsenic, and to prescribe for such ingredients and for the different materials used in their preparation adequate tests which should ensure their freedom from arsenic, beg to report as follows:—

Glucose and invert sugar are ingredients of beer, and it has been established that these sugars may become contaminated by arsenic if mineral acids containing arsenic have been used in their preparation.

"Priming" and caramel, if made from such contaminated sugars, may also be contaminated by arsenic. Other ingredients used by the brewer, if made by the agency of impure sulphuric or hydrochloric acid, may likewise become contaminated by arsenic.

It has been further established that malt may become contaminated by arsenic if the fuel used in its preparation contains arsenic.

Hops are also liable to contain arsenic if they have been sprayed with arsenical preparations, or if they have been "sulphured" with impure sulphur, or if the fuel used in drying them is arsenical.

In an appendix to this report we specify in detail (1) the individual ingredients of beer which are liable from their origin or mode of preparation to be contaminated by arsenic; (2) the materials used in the preparation of such ingredients which are liable to contain arsenic.

Broadly speaking, all the ingredients of beer liable to contain arsenic are comprised under the main groups of (1) malt; (2) malt substitutes (prepared sugar, caramel, and malt extract); (3) hops and hop substitutes; (4) yeast and yeast foods; (5) chemicals employed as cleaning and preservative agents; and (6) finings.

The materials used in the preparation of the ingredients of beer which are liable to contain arsenic are, as already stated, mainly the common mineral acids, and especially sulphuric acid and hydrochloric acid, sulphur, and fuel.

All the evidence we have been able to collect appears to indicate that the arsenic which may be present in the ingredients of beer is in the form of the oxides of arsenic, either free or combined. A study of the behaviour of solutions derived from these ingredients as regards their deportment towards chemical re-agents serves to substantiate this conclusion.

The task entrusted to the Committee was to prescribe tests whereby arsenic, if present, might be readily and certainly detected, and, if necessary, its amount determined, in any of the members of these groups of substances.

Although the recommendation of the Royal Commission above referred to makes no explicit reference to a test for arsenic in beer, as distinguished from its ingredients and the materials which may have been used in their preparation, we have considered that the question of the application of such a test to beer might be regarded as coming within the terms of our reference.

We have, therefore, given attention to the methods of detecting the presence and determining the amounts of arsenic in (1) malt; (2) malt substitutes; (3) wort; (4) hops and hop substitutes; (5) beer; (6) yeast and yeast foods; (7) chemicals; (8) finings; (9) fuel.

Of the various methods which have been suggested from time to time for the detection and estimation of the relatively small quantities of arsenic which may be present in beer and the ingredients of beer, or in the materials which may be used in their preparation, we are of opinion that those methods which depend upon the conversion of the arsenic into arseniuretted hydrogen, and the subsequent deposition of the arsenic in the elementary form by heating the gas, are, on the whole, to be preferred.

The arseniuretted hydrogen may be formed in practice by the action of so-called "nascent" hydrogen upon the arsenic present. The hydrogen may be evolved either electrolytically or through the agency of dilute hydrochloric acid upon zinc admixed with or containing such an amount of copper or other suitable metal as to give rise to a sufficiently rapid evolution of the gas.

The amount of the arsenic deposited by heating the arseniuretted hydrogen so formed is then determined by comparison with deposits obtained in precisely the same manner from wort, beer, malt extracts, sugar solutions, etc., containing known quantities of arsenic.

I.—ELECTROLYTIC METHOD.

An electrolytic method for detecting arsenic appears to have been first suggested by the late Professor Bloxam, of King's College (Quarterly Journal of Chemical Society, Vol. XIII., 1861, pp. 12 and 338), but in its original form it had several disadvantages which have prevented it from being generally adopted by chemists. Modifications of it have been made by Mr. Trotman, Mr. Bevan, and others. The process has been carefully investigated in the Government Laboratory, and in the form now described it is easy of application, and is capable of giving trustworthy results with a comparatively small expenditure of time and trouble.

The apparatus employed in the electrolytic method is seen in plan and elevation in Figures 1 to 4, drawn to scale.

It consists of the following parts:—

1. A glass vessel A, provided with a ground glass stopper and connections B, and calcium chloride drying tube C.
2. A porous cell D.
3. A glass vessel E.
4. A cooling vessel F.
5. A hard glass constricted tube G.
6. A small Bunsen burner H.

The glass vessel A forms with the porous vessel D the inner cell for the cathode where the hydrogen and arseniuretted hydrogen are produced on passing the electric current. The vessel A is open at the bottom and fitted at the top with the ground glass stopper B, through which is passed to a point just below the neck of the vessel the stem of the tapped funnel. The glass stopper also carries the gas exit tube on which is a bulb. The tube is bent as shown in the drawing, and is connected by grinding with the drying tube C. Through the glass cap is fused a stout platinum wire for making the connection on the outside with the current, and within the vessel with the electrode.

The inner electrode, forming the cathode, is of sheet platinum and cone-shaped, with several perforations. It is suspended from a hook made on the end of the wire passing through the glass stopper, and is adjusted so that when the stopper is inserted in the vessel the lower edge of the electrode is 1 mm. above the bottom of the vessel A. It is then securely attached to the wire by closing the hook.

The porous vessel D is larger by 3 to 3mm. in diameter and in depth than the cylindrical portion of the glass vessel A. As seen in the figure, A rests by means of its bulged-out shoulder upon the upper edge of D. The

porous vessel is of unglazed highly silicious ware—of the composition employed for the well-known biscuit filters, first made by Dr. Pukal—and is from 1 to 1·5 mm. in thickness.

The cell for the anode consists of the stout vessel E upon the flat bottom of which the porous vessel D, containing the glass vessel A, stands. The anode consists of a band of platinum 2 cm. broad passing loosely round the porous cell, and connected with the current by means of a stout platinum wire. The liquid in the vessel E should be kept below 50°C., and the vessel E is therefore placed in a larger dish F containing cold water.

The drying tube C is packed as follows:—A plug of cotton wool is first inserted, and then pure granulated anhydrous calcium chloride,* in pieces about the size of small shot or malt grains, for a length of 5 cm. Another loose plug of cotton wool is placed upon the calcium chloride, followed by a roll of lead acetate paper. This is prepared by soaking filter paper in a cold saturated solution of lead acetate and then drying the paper in air. The paper is cut into strips about 1 cm. broad, and rolled into a coil fitting loosely in the tube. A small spiral coil of lead acetate paper is also placed within the enlarged end of the exit tube to which the calcium chloride tube is attached.

To the other end of the drying tube there is fixed by means of a short piece of unvulcanised rubber tubing the hard glass constricted tube in which the arsenic is to be deposited. The ends of the drying tube and the hard glass tube should be in close contact beneath the rubber. To make one of these tubes a piece of Jena glass tubing having an external diameter of 5 mm. and an internal diameter of 3·5 mm. is cleaned by successive treatment with acid, water, and alcohol, and dried. It is then held in the blow-pipe flame, so that a portion of the tube about 2 cm. in length and 5 cm. from the end of the tube is thoroughly softened, when the heated portion is drawn out to a length of 7 to 8 cm., and having at a distance of 1 cm. from the shoulder of the tube an external diameter of 2 mm.—a size which should be maintained as nearly as possible throughout the length of the constricted part. The tube is cut off near the end of the drawn-out portion, the last 1 cm. of which is turned up at right angles. The hard glass tube is supported in a horizontal position when attached to the drying tube of the apparatus, by resting in the slots on the upper edge of the cone which surrounds the flame of the small Bunsen burner. A piece of platinum gauze about 2 cm. square is wrapped round the hard glass tube at the point where it is to be heated by the Bunsen flame.

The small Bunsen burner has a circular base 12 mm. high, and its tube is 6 cm. in height, and 5 mm. in internal diameter. The upper portion of the tube is threaded, and carries a gallery upon which rests a copper cone. The upper edge of the cone contains two slots to receive the hard glass tube.

The apparatus, when worked in the manner to be described, has an apparent resistance of 1·4 ohms, the potential difference between the ends of the wires of the poles being 7 volts with a current of 5 ampères. This strength of current gives about 40 cb.c. of hydrogen in a minute, which furnishes a steady flame about 2 mm. in height, and is the strength of current recommended to be used for the purposes of the test. To effect the reduction of the intensity of the main laboratory supply, which is the most convenient source of the current, a rheostat of incandescent lamps may be employed. The lamps are arranged parallel with each other, but in series with the apparatus, and according to the current desired, lamps of different candle power may be inserted. An ampère meter is included in the circuit.

The apparatus may be arranged for the simultaneous execution of a number of tests. By suitable construction on the charging board, the electric current passes through the solutions arranged in series, and any of these may be brought into or cut out of the circuit as desired. The current is brought to the required strength—4·5 to 5 ampères—by the introduction in the rheostat of lamps of the requisite power according to the number of tests to be carried out simultaneously. A diagram illustrating the method employed for this purpose is shown in Fig. 5.

The sulphuric acid solution employed in the apparatus is prepared by mixing one volume of pure concentrated sulphuric acid with seven volumes of water. It must, of course, be tested to ascertain its freedom from arsenic before it is used. Appendix 21.

Certain of the solutions to be tested are very liable to froth when introduced into the apparatus. This inconvenience may be obviated by adding one or two cubic centimetres of rectified amyl alcohol (b.p. 128°—132°C.) to the acidulated liquid undergoing electrolysis.

Before describing the application of the test, it will be convenient to give in detail the methods to be followed in preparing the extracts or solutions of the various substances in such a form and in such an amount as to render them suitable for testing.

(1.) Malt.—Unground malt may readily be examined for arsenic by washing the malt with warm dilute acid, and testing the acid extract; but this method is inconvenient in the case of a ground or crushed malt, as there are difficulties in obtaining a suitable extract. A ground malt is therefore incinerated in presence of lime and magnesia, and the solution of the ash tested. Direct experiment has shown that deposits of arsenic obtained after treatment of an unground malt with dilute acid are equal in intensity to those obtained by the basic method of treatment of the same malt. The two methods are as follows: —

Basic Method for Ground Malt.—10 grams of the ground malt are transferred to a porcelain, or preferably a platinum, dish about 3in. in diameter, 30 cb.c. of arsenic-free lime water † are added, and the dish heated over a small Bunsen flame for a few minutes. About 0·5 gram of arsenic-free magnesia or lime is then added, and thoroughly mixed with the contents of the dish, the heating of which is continued until the organic matter is completely charred. The dish is then placed in a muffle furnace, or over a low Bunsen flame, and heated at a dull red heat until practically all the carbon is burnt off. When cold the ash is moistened with water, and 20 cb.c. of the dilute sulphuric acid added. The dish is warmed, and the contents transferred to a 4oz. flask. About half a gram of potassium metabisulphite is added, and the solution boiled until free from sulphurous acid. After cooling, the solution is ready to be tested.

Acid Method for Unground Malt.—40 grams of malt are transferred to a wide-mouthed stoppered bottle, 40 cb.c. of the dilute sulphuric acid, and 60 cb.c. of water, are mixed together, raised to a temperature of 50° C., and added to the malt. The bottle is shaken at intervals during 20 minutes, and the liquid poured off. Twenty-five cb.c., representing 10 grams of malt, are transferred to a small flask, half a gram of potassium metabisulphite added, and the solution boiled until free from sulphurous acid. When cold the solution is used for the test.

(2) Malt Substitutes (Glucose, Invert Sugar, Caramel, etc.).—Five grams are weighed in a small flask, and dissolved in 20 cb.c. of water. Half a gram of potassium metabisulphite and 5 cb.c. of the dilute sulphuric acid are then added and the solution boiled until free from sulphurous acid. When cold it is ready for adding to the electrolytic apparatus.

(3.) Wort.—Direct experiments have shown that when using the electrolytic apparatus it is unnecessary to destroy the organic matter of the wort. All the arsenic which may be present is evolved as arseniuretted hydrogen.

For the test, 25 cb.c. of the wort are placed in a small flask, half a gram of potassium metabisulphite and 5 cb.c. of the dilute sulphuric acid are added, and the solution boiled until free from sulphurous acid. When cold the solution is used for the test.

(4) Hops and Hop Substitutes.—Five grams of the substance, ground if necessary in a mortar, are placed in a platinum dish treated with lime and magnesia and incinerated, and the examination for arsenic carried out in the same manner as described in connection with ground malt.

(5) Beer.—Direct experiments have shown that when the electrolytic apparatus is used it is unnecessary to

* Where a series of experiments is carried out with the same apparatus, the calcium chloride should be renewed from time to time, say, after three or four experiments.

† The lime water, lime, magnesia, and potassium metabisulphite are tested as to their freedom from arsenic by the method described under "Chemicals."

Appendix 21.

destroy the organic matter of the beer. All the arsenic which may be present is evolved as arseniuretted hydrogen.

Twenty-five cb.c. of beer are placed in a small flask, half a grain of potassium metabisulphite and 5 cb.c. of dilute sulphuric acid added, and the solution boiled until free from sulphurous acid. The cold solution is used for the test.

(6) Yeast and Yeast Foods.—Five grams are introduced into a flask and gently warmed with 20 cb.c. of water. Half a gram of potassium metabisulphite and 5 cb.c. of dilute sulphuric acid are then added and the contents of the flask boiled until free from sulphurous acid. The cold solution is used for the test.

Of liquid yeast foods 25 cb.c. are taken, and the solution boiled, after the addition of potassium metabisulphite and sulphuric acid, until free from sulphurous acid.

(7) Chemicals:—

(*a*) Sulphites.—Of solid sulphites 1 gram is dissolved in 25 cb.c. of water in a small flask. Five cb.c. of dilute sulphuric acid are added and the solution boiled until free from sulphurous acid. The cold solution is used for the test.

Of solutions of sulphites 25 cb.c. are taken and boiled in like manner after the addition of 5 cb.c. of dilute sulphuric acid. The liquid is tested by the addition of a little more sulphuric acid to ascertain if the whole of the sulphite has been decomposed.

(*b*) Acids.—Sulphuric Acid.—Five cb.c. are diluted with 20 cb.c. of water, half a gram of potassium metabisulphite added, and the solution boiled to expel sulphurous acid. When cold the solution is used for the test.

Hydrochloric Acid.—Five cb.c. are placed in a porcelain dish, and diluted with about 5 cb.c. of water. Five cb.c. of pure nitric acid (Sp. Gr. 1·4) and 2 cb.c. of pure concentrated sulphuric acid are then added, the dish placed on a sandbath, and the liquid evaporated until the sulphuric acid fumes. The dish is removed, and when cold about 20 cb.c. of water and half a gram of potassium metabisulphite added. The solution is transferred to a flask and heated until free from sulphurous acid, and then tested.

(*c*) Sulphur.—Ten grams are taken, and the examination for arsenic carried out in the manner described under Fuel (*see* below). Owing to the readiness with which sulphur sublimes, the temperature to which the hard glass tube is heated should be as low as possible consistent with the burning of the sulphur, and the empty portion of the hard glass tube, next to the bent and drawn out end, should not be heated until the sulphur in the other part of the tube has been burnt. The liquid in the absorption tube is boiled to expel sulphurous acid, and any sulphur or other solid substance which may have passed into the absorption tube in the process of combustion is rendered soluble and in suitable condition for addition to the electrolytic apparatus by the method described for treating the ash of fuel.

(*d*) Other Chemicals.—Of solids 1 gram is taken and dissolved in 25 cb.c. of water. Of liquids 25 cb.c. are taken. In either case, if the solution is alkaline it must be neutralised by the addition of dilute sulphuric acid. To the neutral liquid half a gram of potassium metabisulphite and 5 cb.c. of dilute sulphuric acid are added, and the solution boiled until free from sulphurous acid. The cold solution is used for the test.

(8) Finings.—Five grams are weighed out in a flask, 20 cb.c. of water added, and gently warmed to effect solution. If sulphurous acid or a sulphite is present, 5 cb.c. of the dilute sulphuric acid are added, and the solution boiled until free from sulphurous acid.

If no sulphurous acid is present in the finings, half a gram of potassium metabisulphite is added to the solution prepared as above, together with 5 cb.c. of the dilute sulphuric acid, and the solution boiled to expel sulphurous acid, and then tested.

(9) Fuel.—A piece of hard glass tube A, about 60 c.m. long, is drawn out and the drawn out portion bent, as seen in Figure 6. Ten grams of the finely-powdered sample of fuel are then introduced into the tube in such manner that it occupies about 30 c.m. of the length of the tube, leaving about 6 c.m. of the tube next to the bent and drawn out portion empty. A convenient method of introducing the fuel is to distribute it along a stout glazed cardboard trough or gutter which can readily be inserted in the tube held in a horizontal position, and with the bent portion pointing vertically upwards. On turning the tube round through 180°, so that the bent portion points downwards, the powdered coal falls from the gutter and is loosely distributed along the length of the tube, when the cardboard gutter may be withdrawn. The drawn out portion of the tube is then connected with the absorption apparatus B containing dilute sulphuric acid. A convenient form of apparatus consists of a modified de Koninck absorption tube, the straight limb of which contains glass beads or short lengths of thin glass tubing so as to offer a considerable wetted surface to the passage of the gaseous products of combustion. The hard glass tube A is placed in an ordinary combustion furnace and connected with a supply of oxygen. The burners of the furnace beneath the empty portion of the tube are first lighted, a rapid current of oxygen passing meanwhile through the apparatus. The powdered fuel is then heated at the place where the stream of oxygen first strikes it. As soon as the combustion has started, very little external heat will be required, and the coal or coke gradually burns away without the formation of soot or tarry products. The whole operation is under perfect control, and is finished in from two to three hours, depending upon the nature of the fuel. The ash is left in a loose pulverulent form, and is readily detached from the tube. The arsenic present in the fuel will be found partly in the ash and partly in the constricted end of the hard glass tube and in the liquid in the absorption apparatus.

To determine the amount of arsenic retained by the ash, this is shaken out into a Wurtz flask A of about 100 cb.c. capacity, which is then attached, best by grinding, as shown in Figure 7, to a small reflux condenser B, connected with a flask C of about 70 cb.c. capacity, containing about 10 cb.c. of pure, *i.e.*, arsenic-free hydrochloric acid of Sp. Gr. 1·1. Into the flask A containing the coal-ash 25 cb.c. of arsenic-free hydrochloric acid containing 0·25 cb.c. of bromine are added by means of the ground-in tap funnel D. In practice it is convenient to prepare a stock of brominated hydrochloric acid by adding 1 cb.c. of bromine to each 100 cb.c. of acid of Sp. Gr. 1·1. The flask is then heated and the liquid maintained in gentle ebullition for about two hours. After cooling, about a gram of potassium metabisulphite is added, and the liquid again heated until the free bromine disappears. The solution is filtered from the suspended silica, which, together with the small filter, is washed with the acid contained in the small flask C. Unless the silica is removed the solution is apt to boil irregularly, and it is difficult to distil it properly. The filtered solution is returned to the distilling flask, still connected with the reflux condenser, and boiled to expel the sulphurous acid. The condenser is then reversed and the liquid distilled into the small flask C, the distillation being continued until the residue in the flask A is syrupy, when a further addition of 10 cb.c. of hydrochloric acid is made to the residue and the solution again distilled. The total distillate is made up to 100 cb.c. and an aliquot portion taken for testing. This is transferred to a small porcelain dish, 5 cb.c. of pure nitric acid (Sp. Gr. 1·4) and 2 cb.c. of pure concentrated sulphuric acid are added, and the solution evaporated until fumes of sulphuric acid are freely evolved. The dish is cooled, and the liquid diluted with about 20 cb.c. of water and transferred to a small flask. Half a gram of potassium metabisulphite is added, and the solution boiled until free from sulphurous acid, and when cold used for the test.

To determine the amount of arsenic which is volatilised in the combustion of the fuel, the acid in the absorption tube is poured into a small beaker, and the absorption tube rinsed with a small quantity of water. The end of the hard glass tube is then well washed by repeatedly drawing the liquid in the small beaker into it. Finally, the hard glass tube is rinsed out with a little more acid, and the whole of the solution and washings made up to 50 cb.c. Of this 25 cb.c. are taken and used directly for the test.

Mode of Working.

The electrolytic apparatus, as already described, is arranged for the test, and the test carried out in the following manner. The cells, electrodes, and glass vessel A with the cap, funnel, and exit tube, are thoroughly cleaned and rinsed with distilled water. The porous vessel D containing the vessel A is placed in E, which is surrounded by cold water contained in the glass dish F. The calcium chloride tube C, which has been packed in the manner described, is fitted on the ground glass connection. The hard glass tube G is attached by the rubber connection to the drying tube, so that the bent portion at the end is in an upright position, and the platinum gauze is so arranged on the tube that it just overhangs the shoulder. The small Bunsen burner H is placed beneath the tube which rests in the slots on the upper edge of the cone in such a position that when lighted the flame will heat about 2 cm. of the tube just before the constriction commences.

The connections with the battery wires are made by means of binding screws in such a manner that the current will pass from the vessel E to the cell D; 30 cb.c. of dilute sulphuric acid are then poured into E, containing the anode, and 20 cb.c. of dilute acid are also run into the cell D by means of the stoppered funnel B, the stem of which must be left full of liquid.

When all the connections are complete, and the acid has been added, the current is switched on and the time noted. At the end of 10 minutes the apparatus is practically free from air, and the issuing hydrogen may be lighted. At the same time the Bunsen burner is lighted and the flame carefully adjusted so that the small piece of platinum gauze is maintained at a red heat throughout the experiment. The heating of the tube during the passing of the gas is continued for 15 minutes, and if during that time no brown ring or deposit of arsenic has been formed in the constricted tube (best seen by holding a white card beneath the tube) the apparatus and the acid may be considered free from arsenic and suitable for the application of the test. Two cb.c. of amyl alcohol are then run into the inner cell D by means of the tapped funnel B. This is at once followed by the addition of the solution to be tested prepared as described, 5 cb.c. of water being used for rinsing out the containing vessel. No air must be admitted, and the stem of the funnel must be left full of liquid. If arsenic is present in the added liquid a deposit begins to form in the narrow tube, in the course of a few minutes, at a point between 1 cm. and 2 cm. from the heated shoulder. At the end of 30 minutes the whole of the arsenic, except in very extreme cases, will have been deposited in the tube, which is now sealed up while full of hydrogen. This is effected in the following manner. The stopper of the funnel is opened and a small pointed flame is at once directed against the narrow tube at a point 3 cm. from the deposit, between the deposit and the turned up end of the tube, which is meanwhile held by a pair of forceps. The tube at once collapses, and the end is drawn off. The electric current is at the same time disconnected, and then the tube is similarly heated and drawn off just below the shoulder. The deposit of arsenic must on no account be heated by the flame during the sealing of the tube. The short tube, about 4 cm. long, containing the arsenic deposit, may then be mounted on white card for reference.

Of course, if the deposit of arsenic thus obtained should be so considerable as to prevent accurate comparison with the standard deposits, the experiment must be repeated upon a smaller quantity of the substance.

Preparation of the Standard Deposits.—Although there is good reason to believe that the amount of arsenic deposited is in nowise affected by the nature of the substance with which the arsenic may be associated—0·01 mgm. of arsenic in beer, for example, giving a deposit of equal intensity with the same quantity of arsenic in malt—nevertheless, as the quantitative estimation is based on comparison, it is expedient to make use of deposits prepared by the addition of known amounts of arsenic to arsenic-free specimens of each class of substance. By so proceeding, all doubts which may arise from differences in manipulation, or concerning the possible effect of differences in the nature and composition of the substances on the formation of the deposit are obviated. Thus, for example, in the case of hops and malt, although the final solution to be tested is substantially an acid solution of alkaline earths containing a minute quantity of arsenic, nevertheless as the malt and hops behave somewhat differently on incineration, and themselves contain different amounts of inorganic matter, it is advisable to make the standards by which malt and hops are to be compared directly from these substances.

The preparation of a solution of arsenic of definite strength, for this purpose, must be carefully carried out. Pure, resublimed arsenious oxide is ground to a fine powder in an agate mortar, and dried at 100° C. 0·1 gram is accurately weighed on a watch glass, and transferred to a litre flask by washing it down a funnel placed in the neck of the flask with one or two cb.c. of pure concentrated hydrochloric acid. The liquid must not be heated. When the solution is complete, it is diluted to one litre with distilled water, and thoroughly mixed. Each cubic centimetre of this solution (conveniently called A) contains ·0001 gram, or 0·1 mgm. of arsenious oxide. Of this solution 100 cb.c. are carefully measured and transferred to another litre flask, and diluted with water to 1 litre. This solution (conveniently called B) contains in each cb.c. ·00001 gram or ·01 mgm. of arsenious oxide.

Malt.—It is first necessary to obtain a malt free from arsenic. In certain of our experiments malt of this character was obtained by drying green malt by means of steam heat. In others a malt was used which had been dried in cylinders and out of contact with the fumes of fuel. The absence of arsenic in the reagents to be employed must also be ascertained by carrying out a control experiment with the malt, in all respects similar to the actual experiment, but without the addition of arsenic.

Ten grams of arsenic-free malt, previously ground in a mortar, are placed in a porcelain or preferably a platinum dish, and 0·2 cb.c. of standard arsenic solution B, containing ·002 mgm. of arsenious oxide, is added from a sufficiently narrow burette.* The whole is then treated in the manner described in connection with the examination of malt, by the basic method (page 6). Similar deposits are obtained for ·004, ·006, ·008, ·010, ·012, ·014, ·016 and ·018 mgm. respectively.

Hops and Hop Substitutes.—A similar series of standards for hops and hop substitutes is prepared by taking five grams of hops, previously ascertained to be free from arsenic, adding definite amounts of the standard arsenic solution, and carrying out the method of examination as described in connection with hops.

Wort and Beer.—A series of standards is prepared for each of these, by adding to 25 cb.c. of the measured liquid definite amounts of the standard arsenic solution B, the liquid being treated in the manner described in connection with the test for wort and beer.

A series of standard deposits is also made for each of the following groups of substances—malt substitutes (glucose and invert sugar), yeast and yeast foods, and chemicals.

Fuel.—With regard to the standards for fuel, it has been shown by direct experiments that all the arsenic which may be present in fuel is obtained, according to the method described, partly in the hydrochloric acid distillate from the solution of the ash, and partly in the solution containing the arsenic volatilised during combustion; and the amount of arsenic in fuel may be accurately estimated by a comparison of the arsenic deposits obtained from testing the fuel in the prescribed manner with the standards employed in the case of chemicals.

The following table gives the amounts of arsenic, represented by the various standard deposits, converted into grains per pound, or per gallon, or per cwt., according to the nature and amount of the substance tested. In the case of malt the amount of arsenic in grains per pound is converted into its equivalent in grains per gallon of beer on the assumption that a gallon of beer of the standard gravity 1·055 is produced from 2½ lbs. of malt.

* The burette used in our experiments had an internal diameter of 7 mm., and one cubic centimetre occupied a length of 20 mm.

Appendix 21.

Arsenic Deposits obtained from

Standard As_4O_6 Solution.	10 grams Malt.		25 cbc. of Wort, Beer, or other Liquid.	5 grams of Hops, Sugar, Caramel, Yeast, or other substance.	1 gram of Chemicals.	10 grams of Fuel or Sulphur.
Mgm.	Grains per lb.	Equal to Grains per Gallon of Beer.	Grains per Gallon.	Grains per lb.	Grains per lb.	Grains per cwt.
·002	1/175	1/369	1/189	1/360	1/72	·15
·004	1/350	1/154	1/99	1/180	1/36	·31
·006	1/240	1/103	1/60	1/120	1/24	·46
·008	1/180	1/77	1/45	1/90	1/18	·62
·010	1/144	1/62	1/36	1/72	1/14	·77
·012	1/120	1/51	1/30	1/60	1/12	·93
·014	1/105	1/44	1/26	1/51	1/10	1·09
·016	1/90	1/39	1/23	1/45	1/9	1·24
·018	1/80	1/34	1/20	1/40	1/8	1·40

The advantages of the electrolytic method are that:—

1. It obviates the use of zinc.

2. It is simple in execution, is under perfect control, and may be carried out under such conditions that the results obtained by different operators are strictly comparable, inasmuch as with a current-strength of fair regularity the evolution of the gas is practically constant and uniform.

3. The whole of the solution to be tested for arsenic may be added to the apparatus at once, so that during the whole time of testing the arsenic is under the influence of the "nascent" hydrogen.

4. It has been established that such amounts of arsenic as are present in beer or its ingredients are evolved as arseniuretted hydrogen during the 30 minutes occupied by the test. The nature of the material associated with the arsenic is found to exercise no inhibiting effect on the formation and evolution of the arseniuretted hydrogen. Beer and aqueous extracts of malts and worts may be added directly to the electrolytic apparatus without previous destruction of the organic matter as required by the zinc and acid process.

5. The deposits obtained are more uniform in character than those furnished by the zinc and acid method, and admit therefore of more accurate quantitative comparison.

6. The process allows of the simultaneous execution of a number of estimations of arsenic, depending upon the arrangement of the rheostat.

The disadvantages of the methods are:—

1. The initial cost of the apparatus as compared with that employed in the zinc and acid method.

2. That it can only be applied when an electric current of sufficient intensity is available.

II.—ZINC AND ACID METHOD.

In the method in which zinc is employed as a means of generating hydrogen, the apparatus may conveniently take the form represented in Figures 8 to 10, which are drawn to scale.

The flask A is fitted with the ground glass stopper B through which passes the stem of a funnel furnished with a stop-cock. The stopper also carries the exit tube on which is a bulb, and which is bent twice at right angles, and connected by grinding with the calcium chloride drying tube C. The hard glass tube in which the arsenic is to be deposited is connected with the drying tube C in the manner already described. The drying tube, hard glass tube, and Bunsen burner, are, in fact, precisely similar to those used with the electrolytic apparatus.

The materials required are zinc, hydrochloric acid, fuming nitric acid and copper sulphate.

Zinc.—Arsenic is frequently present in zinc. Hence it must be ascertained that the zinc is free from arsenic before it is made use of in the test. It has also been established that some varieties of commercial zinc, owing, it is presumed, to the presence of small quantities of iron, will not furnish a deposit of arsenic when small quantities of arsenic are added to the solution in the hydrogen generating flask. It is therefore necessary, before any tests can be carried out with a particular sample of zinc, to ascertain, firstly, if it is free from arsenic, and secondly, if it yields a normal arsenic deposit from a solution containing a known amount of arsenious oxide when used in the prescribed manner.

Before use in the apparatus the zinc must be granulated. The outer surface of the block of metal is cleaned first by scraping, and then by treatment with hydrochloric acid, after which it is thoroughly washed with water. The zinc, in pieces of a suitable size, is next melted in a Cornish, Hessian, or porcelain crucible in a muffle or other furnace. When the zinc is just melted, or even when some portion of the zinc in the crucible still remains in an unmelted condition, the molten metal is poured in drops from a height of about four feet into cold water contained in a clean vessel. It is then dried, and preserved in a stoppered bottle.

Hydrochloric Acid.—Hydrochloric acid, unless specially purified, generally contains sufficient arsenic to render its application for the purpose of the test useless. Several methods have been suggested for freeing it from arsenic. The plan proposed by the Joint Committee of Public Analysts and of the Society of Chemical Industry (Jour. Soc. Ch. Ind. Vol. XXI., 1902, 49-96; Analyst, Vol. XXVII., 1902, 210), and that published by Dr. Thorne (Proc. Chem. Soc., Vol. XVIII., No. 252, p. 118) have been tested in the Government Laboratory and found to be efficient.

The hydrochloric acid used in the test has a specific gravity of 1·1.

Fuming Nitric Acid.—This re-agent is the pure redistilled nitric acid of specific gravity 1·4 into which oxides of nitrogen have been passed. The nitrous fumes are conveniently generated by the action of nitric acid on starch.

Copper Sulphate.—A 2 per cent. aqueous solution of crystallised copper sulphate is made. Its freedom from arsenic must be ascertained before its use in the test.

Preparation of the substances to be tested.

(1) MALT.—The statements made in connection with the examination of malt by the electrolytic process are applicable to the examination of malt by the zinc and acid process. Direct experiment has shown that the amount of arsenic in unground malt may be estimated either by washing the whole malt with warm dilute hydrochloric acid, or by grinding the malt and examining it by the method for ground malt.

The two methods are:—

Basic Method for Ground Malt.—10 grams of the ground malt are placed in a porcelain, or preferably a platinum, dish, about 3 inches in diameter, and mixed with 30 cb.c. of lime water and 0·5 gram of magnesia or lime.* The whole is then dried and incinerated in the manner described in connection with the electrolytic process. The ash is moistened with water, dissolved in 10 cb.c. of pure hydrochloric acid (Sp. Gr. 1·1), and the solution added to the hydrogen generating flask.

Acid Method for Unground Malt.—40 grams of malt are transferred to a wide-mouthed stoppered bottle. 40 cb.c. of hydrochloric acid of specific gravity 1·1 and 60 cb.c. of water are mixed together, raised to a temperature of 50°C., and added to the malt. The bottle is shaken at intervals during twenty minutes, and the liquid poured off. 25 cb.c., representing 10 grams of malt, are taken for the test.

(2) MALT SUBSTITUTES.—(a) Glucose, Invert Sugar.—5 grams are weighed in a beaker, and dissolved in 20 cb.c. of water. To the solution 10 cb.c. of hydrochloric acid are added, and it is then ready for the test. The amount of sulphurous acid which may be present, even in a bleached glucose, exerts no inhibiting action on the formation of the arsenic deposits.

The examination of the solutions of these substances may also be carried out by one or other of the methods described in connection with wort.

(b.) Caramel, Malt Extracts.—Solutions of caramel and of certain malt extracts, when brought in contact with the zinc and acid, are apt to "froth" inconveniently. They occasionally so retard the action that it becomes difficult or impossible to ensure that the arseniuretted hydrogen is being generated. In these cases the 5 grams of the substance should be treated by one or other of the methods described under wort.

(3) WORT.—It has been established in the case of a malt infusion containing arsenic, and brought in contact with zinc and hydrochloric acid, that the formation of arseniuretted hydrogen is interfered with to such an extent that small quantities of arsenic may escape observation. If, however, the maltose, dextrin, and albuminoid matter contained in the infusion are destroyed, no difficulty is met with in detecting the arsenic.

The destruction of these substances may be effected by incineration with lime and magnesia, or by treatment with fuming nitric acid.

Basic Method.—To 25 cb.c. of the wort, contained in a porcelain or, preferably, platinum dish about three inches in diameter, are added 20 cb.c. of arsenic-free lime water, and 0·5 gram of magnesia. Or 0·5 gram of pure lime may be used in place of the lime water and magnesia. The mixed wort and lime solution must give a decided alkaline reaction to litmus paper. The dish is placed over a low flame, and the liquid evaporated to dryness. The residue is charred and finally heated until the organic matter is destroyed. This may be carried out over a Bunsen flame, or in a muffle furnace heated to dull redness. The ash is moistened with water, and dissolved in 10 cb.c. of the purified hydrochloric acid (Sp. Gr. 1·1). The solution is added to the generating flask.

Acid Method.—25 cb.c. of the wort are put into a 100 cb.c. round-bottomed Jena flask and evaporated to a thick syrup on a sand bath. The syrup is cooled, and 5 or 6 cb.c. of the fuming nitric acid added, the mixture is then very gently warmed until the reaction starts. Care must be taken to moderate it if necessary by immersing the flask in cold water. The flask is then replaced on the hot sand bath and heated until the greater part of the nitric acid has been driven off. To the residue 1 or 2 cb.c. of fuming nitric acid are added, and the flask heated as before to expel the greater portion of the acid. This operation is repeated until a total of about 10 cb.c. of fuming nitric acid has been added. The contents of the flask are finally heated until there is no further evolution of brown fumes. When cold the resulting brownish-yellow crystalline mass is dissolved in 10 cb.c. of hydrochloric acid, diluted with an equal bulk of water, and the solution transferred to the apparatus.

(4) HOPS AND HOP SUBSTITUTES.—Five grams of the substance previously powdered are heated in a porcelain or, preferably, platinum dish with lime water and magnesia, dried and incinerated in the manner described in connection with the electrolytic process. The ash is moistened with water, dissolved in 10 cb.c. of hydrochloric acid, and the solution added to the generating flask.

(5) BEER.—It has been established that no arsenic is lost in the course of fermentation, except that which may be secreted by yeast, or which may be precipitated, as, for example, by the agency of sulphured hops; nor is the arsenic converted, as has been surmised, into cacodylic acid. If any other organic combination of arsenic is formed it is broken up by analytical treatment in such manner that the arsenic may be recovered.

Many finished beers, especially those of low gravity containing arsenious or arsenic oxide will readily yield the arsenic as arseniuretted hydrogen when introduced directly into the apparatus. Experiments have been made on beers containing known quantities of added arsenious oxide, and the resultant deposits are practically equal in intensity to those furnished by aqueous solutions containing similar quantities of arsenic.

Certain of these beers, however, even after boiling, froth to such an extent as to make it difficult to work with them.

Other beers, especially those containing large quantities of dextrinous matter, behave, as regards the formation of arseniuretted hydrogen, like a malt infusion.

As it is desirable that a uniform procedure should be adopted in the case of beer in regard to the destruction of the organic matter as a preliminary to testing for arsenic by the zinc and acid method, we recommend that the beer should be treated like wort, the dextrin and albuminoid matter being destroyed by treatment with fuming nitric acid or by incineration with lime and magnesia.

For the test, 25 cb.c. of the beer are taken and treated as described under wort.

(6) YEAST AND YEAST FOODS.—Five grams of a solid or syrup, or 25 cb.c. of a liquid substance, are taken, and the examination carried out by one or other of the methods described in connection with wort.

(7) CHEMICALS:—

(a.) Sulphites.—Of solid sulphites 1 gram is transferred to a 4oz. flask, and dissolved in 20 cb.c. of water. Five cb.c. of the purified hydrochloric acid (Sp. Gr. 1·1) are added, and the flask placed over wire gauze on the iron ring of a retort stand. In the neck of the flask is placed the glass condensing tube (Fig. 9) 2ft. in length, and having two bulbs about 2in. from the lower end. The tube rests by the lower bulb on the mouth of the flask, and is held in position by a clamp attached to the stand. The liquid is raised to the boiling point, and maintained in gentle ebullition until it is free from sulphurous acid. When cold the solution is added to the apparatus.

Of solutions of sulphites 25 cb.c. are placed in the flask, 5 cb.c. of the hydrochloric acid added, and the solution boiled as above.

The solution must be tested by the addition of a little more hydrochloric acid to ascertain if the whole of the sulphite has been decomposed, and, before adding to the apparatus, the total amount of hydrochloric acid added to the solution must be made up to about 10 cb.c.

(b.) Acids.—Sulphuric Acid.—5 cb.c. are mixed with 20 cb.c. of water. When cold the solution is ready for the test.

Hydrochloric acid.—5 cb.c. are mixed with 20 cb.c. of water and added to the apparatus.

* The lime water, lime and magnesia, are tested as to their freedom from arsenic by the method described under "Chemicals."

Appendix 21.

(c.) Sulphur.—10 grams are taken and the examination for arsenic carried out in the manner already described in connection with the electrolytic process.

(d.) Other Chemicals.—Of solids, 1 gram is dissolved in a mixture of 25 cb.c. of water and 10 cb.c. of hydrochloric acid (Sp. Gr. 1·1).

Of solutions, 25 cb.c. are taken and mixed with 10 cb.c. of hydrochloric acid.

If the solution to be tested has an alkaline reaction, care must be taken that there is an excess of acid before its addition to the flask.

(8) Finings.—Five grams are taken, and the examination carried out by one or other of the methods described in connection with wort.

(9) Fuel.—The examination of fuel for arsenic is carried out in the manner described in connection with the electrolytic method, except that hydrochloric acid is used in the absorption tube instead of sulphuric acid.

For the arsenic in the ash of the fuel, the hydrochloric acid distillate is made up to 100 cb.c. and an aliquot portion taken for the test.

For the arsenic volatilised during the combustion, the acid in the absorption tube and the acid washings of the end of the combustion tube are made up to 50 cb.c. and 25 cb.c. taken for the test.

Mode of Working.

Ten grams of granulated zinc are placed in the flask A and covered with 15 cb.c. of distilled water, to which are added 5 cb.c. of hydrochloric acid. After a minute or two it is thoroughly washed and covered with 15 cb.c. of a 2 per cent. copper sulphate solution, which is allowed to act for about 10 minutes, when the copper-zinc couple produced is repeatedly washed with water.

The flask is then fitted with the stopper B carrying the funnel and exit tube; the drying tube C packed with calcium chloride, and lead acetate paper is fixed on the ground glass end of the exit tube, and the hard glass constricted tube is attached by the caoutchouc connection to the end of the drying tube. The Bunsen burner is also placed in position so that the hard glass tube rests in the slots on the upper edge of the cone of the burner, and in such a position that the flame will heat about 2 cm. of the tube just before the constriction commences. Around this heated part of the tube a piece of platinum gauze is placed.

When all the connections have been made, about 10 cb.c. of hydrochloric acid (Sp. Gr. 1·1) are gradually added. At the end of 10 minutes the apparatus will be practically free from air, and the issuing hydrogen may be lighted. At the same time the Bunsen burner is also lighted, and the heating of the hard glass tube so regulated that the piece of platinum gauze is maintained at a red heat. Then, during 20 minutes, a further quantity of 10 cb.c. of hydrochloric acid is added. The hydrogen flame should be from 2 to 3 mm. in height, and the acid is to be added throughout the experiment so as to secure this. During the 20 minutes' heating of the tube a deposit of arsenic, best seen by holding a white card beneath the tube, will be formed if the zinc or acid is not arsenic free. In such a case the experiment must be discontinued, the flask washed out, and fresh materials employed.

When the materials are thus proved to be free from arsenic, the solution to be tested is gradually run in, so that its addition to the generating flask is spread over a period not exceeding 15 minutes, and the hydrogen flame is maintained at a height of 2 to 3 mm. When the whole of the solution has been added, the generation of the hydrogen is continued for another 15 minutes at least by the addition, as required, of more hydrochloric acid. For that purpose from 10 to 15 cb.c. are needed.

Preparation of the Standard Deposits.—The standard deposits with which the arsenic deposits from tested substances are to be compared must be prepared by the use of a specimen of each kind of substance containing known amounts of arsenious oxide. The quantity of substance taken, and the manner of preparing the solution or extract, must be the same as described under the test for that substance. Every care should be taken that the period of time over which the solution is added, the size of the hydrogen flame, the mode and duration of heating of the glass tube, and the amount of acid used, should be the same in the preparation of the series of standard deposits as in the carrying out of the actual test.

The preparation of the standard arsenic solution has been described in connection with the electrolytic method.

The amounts of arsenic obtained by comparison of deposits may be converted into grains per lb., or per gallon, or per cwt., by means of the table already given.

It will be seen that this process, which has come to be known as the Marsh-Berzelius method, is similar in principle to that recommended by a Joint Committee of the Society of Public Analysts, and of the Society of Chemical Industry, an account of which has already appeared in a number of scientific and technical journals (Jour. Soc. Ch. Ind., Vol. XXI., 1902, 94-96).

The method now described differs from that of the Joint Committee only in certain details, which, however, experience has shown are important. For example, the size of the apparatus employed and the amount of zinc and acid needed are much smaller; the rate of evolution of the gas is less, and the arsenic is deposited over a smaller area of glass, which facilitates comparison with the standards.

The main advantages of this method are that it is sufficiently delicate, is rapid and easy of execution, and that the apparatus and materials needed are comparatively inexpensive.

The disadvantages attending it are:—

1. That zinc very frequently contains small amounts of arsenic, and hence must be carefully tested before use. It has been established that the arsenic when present is not uniformly distributed throughout the metal, and hence different portions of zinc from the same granulation may contain arsenic in very different amounts. It has been further shown that small quantities of admixed metals, and apparently iron in particular, tend to prevent the formation of arseniuretted hydrogen, and so prevent the detection of minute quantities of arsenic.

It is necessary therefore to ascertain not only that the zinc is free from arsenic, but that it will give rise to arseniuretted hydrogen when arsenic is actually brought in contact with it.

2. The character of the deposit of arsenic is influenced by the rate at which the hydrogen is evolved, and as this depends upon the "activity" of the zinc, which is not always under complete control, the deposits obtained by different operators, or with different specimens of zinc, are apt to show slight variations.

We desire to record our appreciation of the skill and care with which Messrs. Stubbs and Cheater, assistants in the Government Laboratory, have worked out the details of the several analytical processes described in this report.

We are also indebted to Dr. Dunn and Dr. H. S. Pattinson, of Newcastle-on-Tyne, for much valuable assistance, especially in connection with the zinc and acid method.

We have the honour to be, Gentlemen,
Your most obedient servants,

T. E. Thorpe, Chairman,
William A. Tilden,
Harold B. Dixon,
Graham Aldous,
John Pattinson.

March 11, 1903.

APPENDIX.

(A.)—Ingredients of Beer which are liable, from their Origin or Mode of Preparation, to be Contaminated by Arsenic.

(1.) Malt:—

Malt may be contaminated by arsenic in the process of kiln drying if the products of the combustion of the coal or coke or the ash of the fuel are allowed to come in contact with the grain.

(2) Malt Substitutes:—

(a) Solid and Liquid Glucose.—Solid glucose is composed mainly of dextrose, and liquid glucose mainly of maltose and dextrin; and both are manufactured from starch by treatment under pressure with hot dilute mineral acid, and subsequent evaporation after removal of the acid. The mineral acid unless specially purified is liable to contain arsenic, part of which may remain in the finished glucose.

(b) Invert Sugar or Saccharum.—Invert sugar is composed mainly of dextrose and levulose, and is manufactured from ordinary sugar or sucrose by treatment with acid in a manner similar to that in which glucose is prepared from starch.

(c) Extract of Malt, Malt Extract, or Maltodextrin, is composed mainly of maltose and dextrin, and is obtained by evaporating infusion of malt to the desired consistency.

(d) Caramel and Colourings are prepared by heating solid or liquid glucose or cane sugar. Priming and colouring solutions are often prepared from them.

Malt substitutes are sold under various proprietary and trade names indicative in most cases of their composition, origin, or action on polarised light.

(3.) Hops :—

Arsenical contamination may occur during the process of kiln drying by contact of the hops with products of combustion of coal and coke, or may arise from "sulphuring" with impure sulphur, or from spraying with arsenical preparations.

Certain so-called "Hop Compos," or hop substitutes, may contain, in addition to other vegetable bitter or astringent principle, a certain proportion of hops. If the hops so used have been sprayed with arsenical preparations, or dried by means of arsenical fuel, or sulphured with impure sulphur, these substitutes may be contaminated by arsenic.

(4.) Yeast and Yeast Foods :—

Yeast is occasionally contaminated, probably from growth in worts containing arsenic.

Yeast, malt combings, spent grains, and phosphates are used in the preparations of yeast foods. These articles are known generally as maltopeptones ; but they are advertised under a variety of trade names.

(5.) Chemicals :—

(a) Sulphites.—The sulphites and bisulphites of the alkalis and alkaline earths are used in beer as preservatives. Sometimes a little Extract of Quillaia is added to the sulphite and the mixture sold as a "frothing" agent. These substances are advertised as "antiseptic," "keeping," "preservative," "foaming," "frothing," and "heading" powders, but the majority pass under trade and proprietary names.

(b) Carbonates.—Alkaline carbonates are occasionally used to "correct" or neutralise the acidity of old or sour beer ; preparations of this kind are sometimes known as neutralisers or regenerators.

(c) Hardening salts.—Carbonates, chlorides, and sulphates of the alkalis and alkaline earths are often added to waters naturally deficient in such salts.

(d) Sulphur.—Sulphur dioxide, obtained by burning sulphur in air, is sometimes used in the purification of foul casks.

(6.) Finings.

Finings may occasionally become contaminated by minute traces of arsenic from the circumstance that isinglass or gelatine used in their preparation is "cut" or softened by old beer or sulphurous acid.

(B.)—Materials Used in the Preparation of the Ingredients of Beer which are Liable to Contain Arsenic.

(1.) Mineral Acids (mainly hydrochloric and sulphuric acids) :—

These are used in the preparation of solid and liquid glucose and invert sugar.

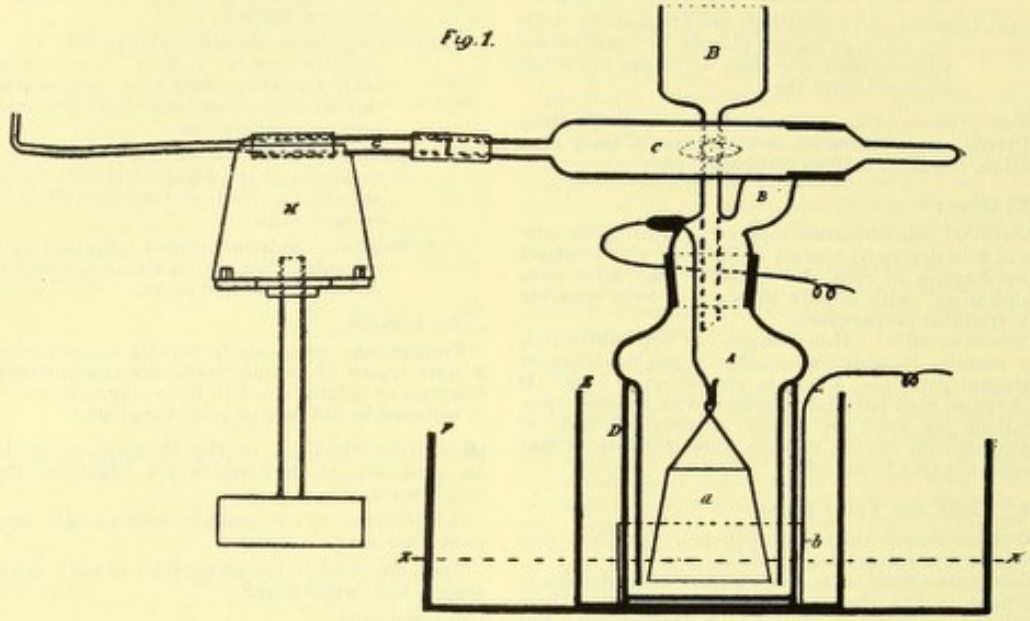
(2.) Sulphur.

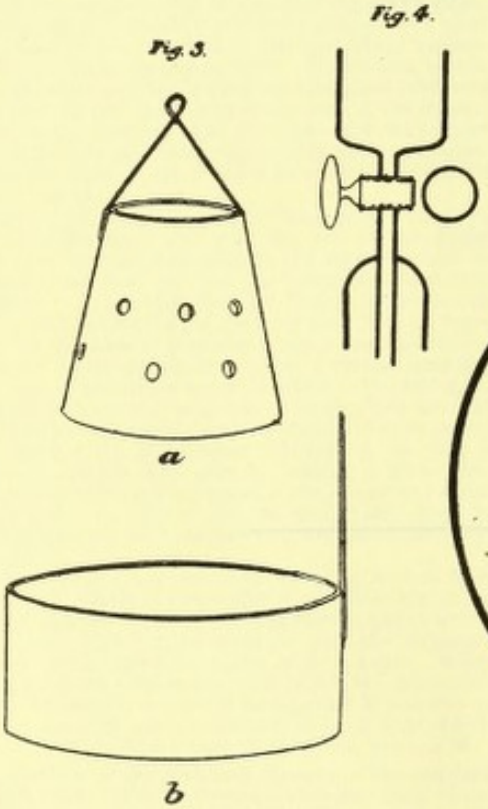
(3.) Fuel.

Appendix 21.

APPENDIX, No. 21.

APPARATUS FOR THE ELECTROLYTIC PROCESS





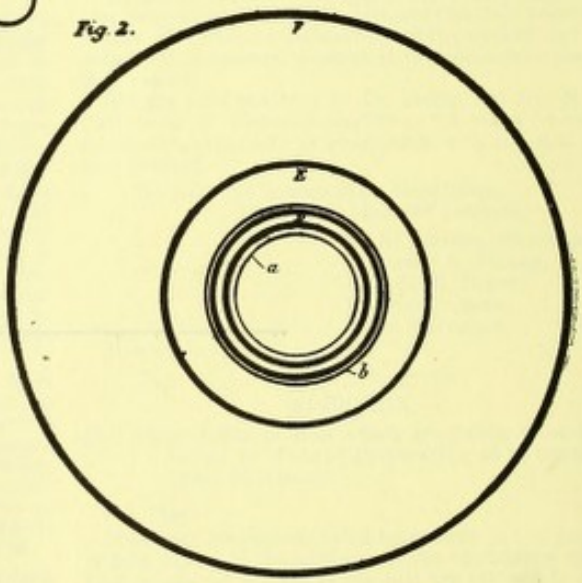


FIGURE 1 (Scale $\frac{3}{4}$ths).
Side Elevation.

A.—Glass vessel.
B.—Stopper, exit tube, and funnel.
C.—Drying tube.
D.—Porous vessel.
E.—Glass cell.
F.—Glass dish for cold water.
G.—Hard glass constricted tube.
H.—Small Bunsen burner.
a.—Cathode.
b.—Anode.

FIGURE 2 (Scale $\frac{3}{4}$ths).
Horizontal section at X, X, in Figure 1.

FIGURE 3 (Full size).
The two platinum electrodes.

a.—Cathode.
b.—Anode.

FIGURE 4 (Scale $\frac{3}{4}$ths).
Vertical section through B and C in Fig 1.

APPENDIX, No. 21—*continued*

APPARATUS FOR THE ELECTROLYTIC PROCESS—*continued.*

Fig. 5.

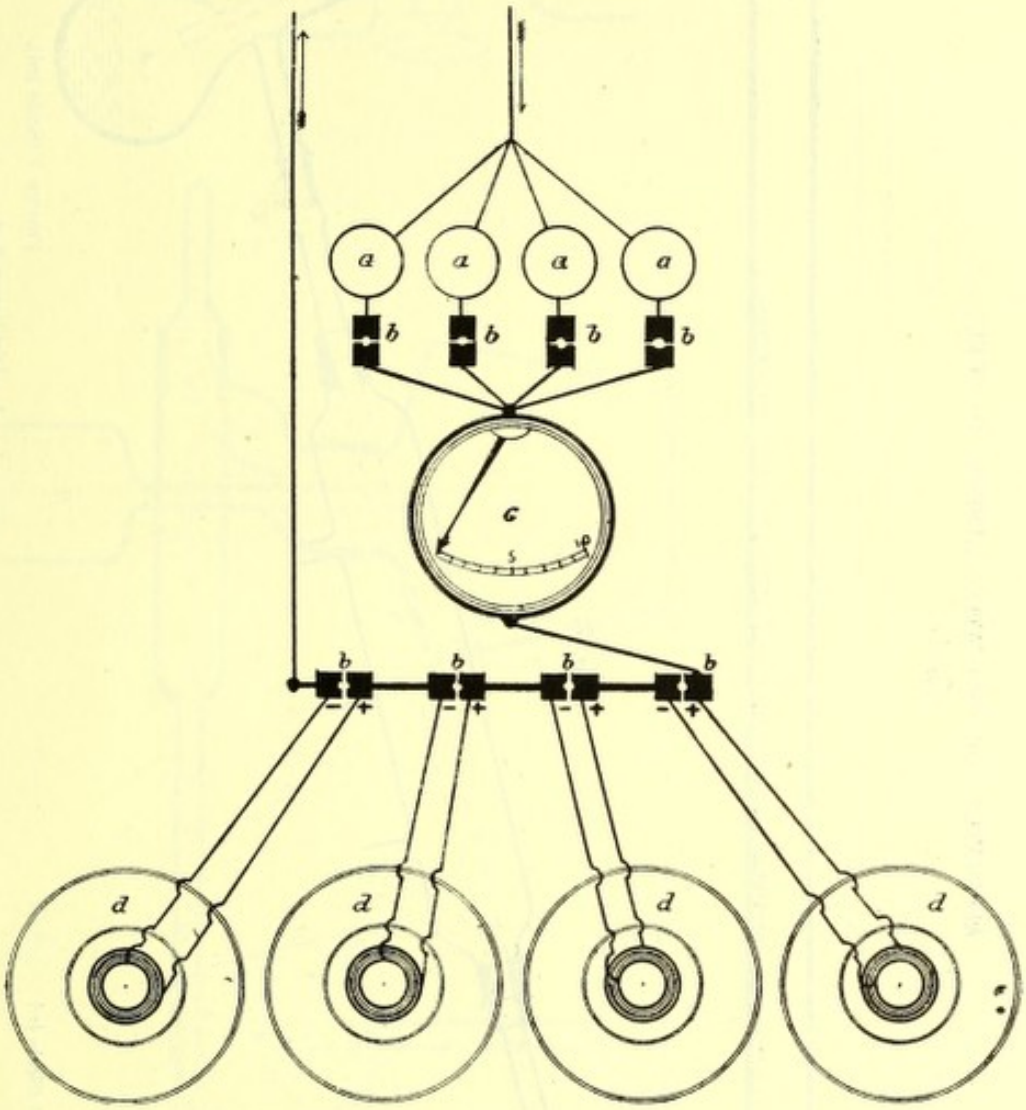


FIGURE 5. (Scale ¼th.)

Diagram of the rheostat and charging board arranged for four simultaneous tests.

The arrows show the direction of the current.

a, *a*, *a*, *a*.—Lamps by means of which the current is reduced to the required strength.

b, *b*, *b*, *b*.—Switches.

c. Ammeter.

d, *d*, *d*, *d*.—Electrolytic cells as in Figure 1.

APPENDIX, No. 21—*continued.*

APPARATUS FOR ESTIMATING ARSENIC IN FUEL.

Fig. 6.

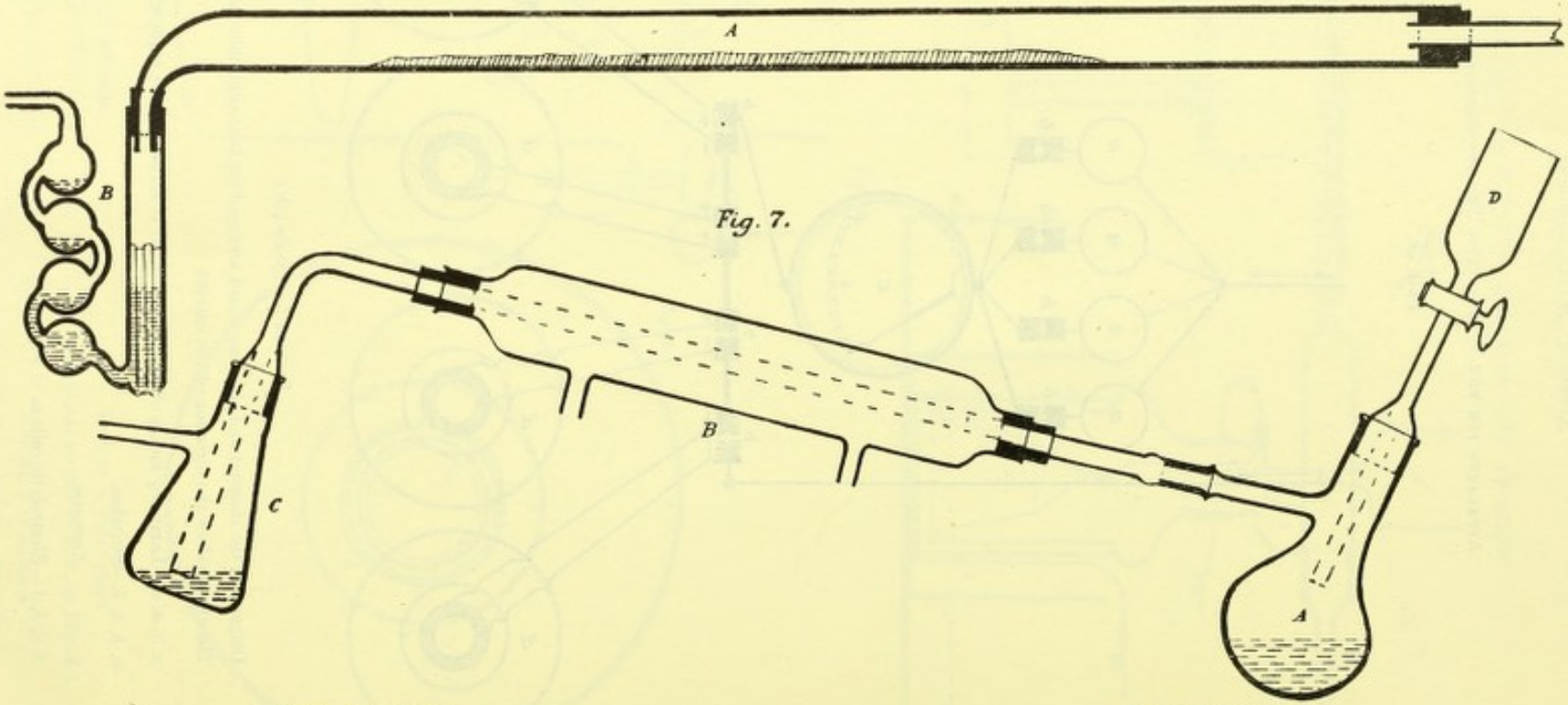


FIGURE 6 (Scale ½rd

A.—Hard glass tube.
B.—Absorption tube.

Fig. 7.

FIGURE 7 (Scale ½rd).

A.—Distillation flask.
B.—Condenser.
C.—Flask for receiving distillate
D.—Funnel.

APPARATUS FOR THE ZINC AND ACID PROCESS.

Fig. 8.

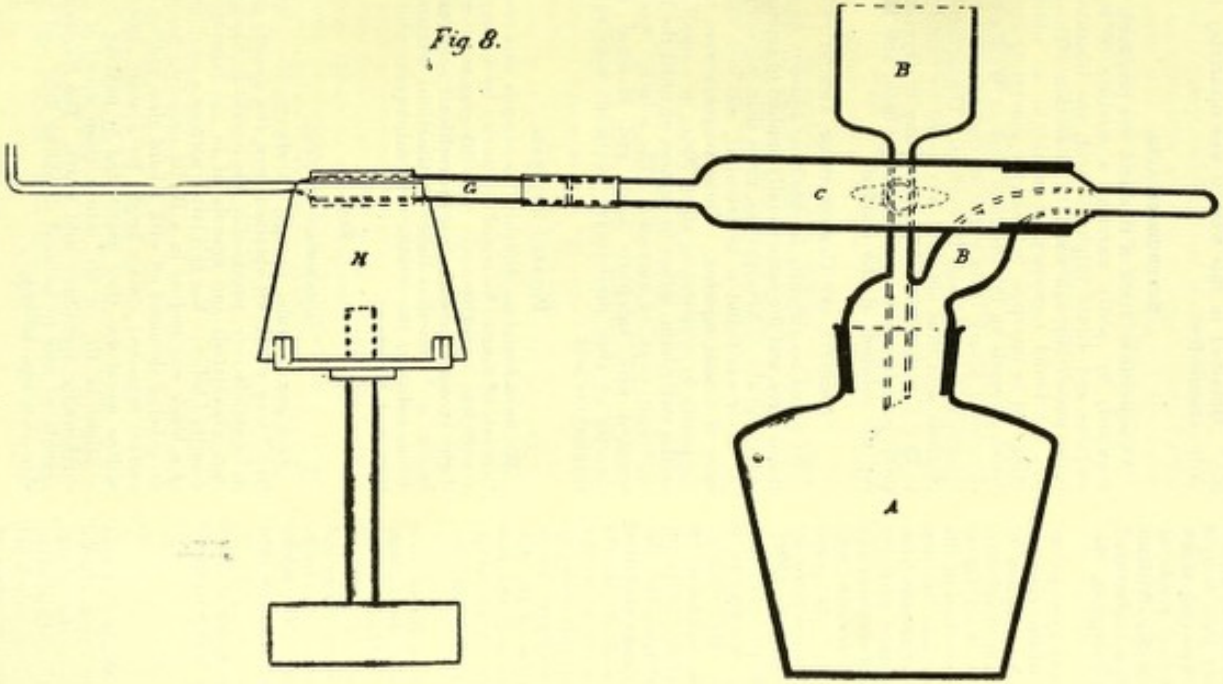


Fig. 10.

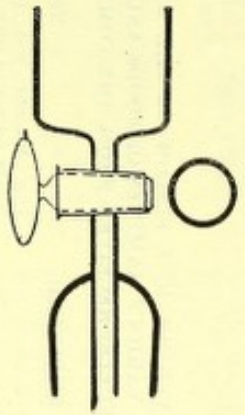


Fig. 9.

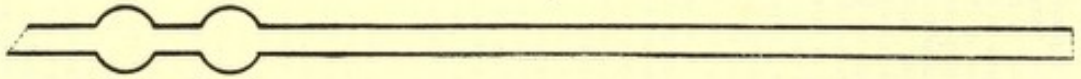


FIGURE 8 (Scale $\frac{4}{7}$ths).

Side Elevation.

A.—Flask in which hydrogen is generated.
B.—Stopper, exit tube, and funnel.
C.—Drying tube.
G.—Hard glass constricted tube.
H.—Bunsen burner.

FIGURE 9 (Scale $\frac{1}{4}$th).

Reflux condensing tube.

FIGURE 10 (Scale $\frac{4}{7}$ths).

Vertical section through B and C in Figure

APPENDIX 22.

TESTS FOR ARSENIC IN FOODS, ETC.

REPORT BY DR. G. McGOWAN AND MR. R. S. FINLOW ON THE METHODS EMPLOYED IN TESTING FOR ARSENIC THE VARIOUS SAMPLES OF FOODS AND OTHER SUBSTANCES (NOT INCLUDING FUELS) RECEIVED FROM THE COMMISSION.

A.—PURIFICATION OF REAGENTS EMPLOYED.

Hydrochloric Acid.

So far as our experience goes, the hydrochloric acid which is sold as "arsenic-free" requires in nearly every instance to be further purified, this being no doubt largely due to the fact of its being stored in bottles, the glass of which contains arsenic as an ingredient. The preparation of a perfectly pure sample has often been a matter of difficulty, involving much loss of time, more especially in the earlier stages of our work. A useful suggestion made by Sir William Ramsay, that special bottles might be manufactured without any arsenic for storing such reagents, deserves recording in this connection.

We first tried the method recommended by the Conjoint Committee (Appendix No. 20), which consists shortly in treating the diluted acid with excess of bromine and then with excess of a solution of sulphurous acid. After this final mixture has stood for at least two hours, it is distilled; the first portions of the distillate containing all the sulphurous acid are discarded, while the residual acid should be arsenic-free. With some samples we were able to obtain perfectly pure acid* by this method, but in many other instances we found it impossible to prepare either a residual acid or a distillate acid free from arsenic. For this reason we ultimately turned to the process recommended by Thomson ("British Food Journal," October, 1902), viz., the distillation of impure hydrochloric acid—preferably diluted with water down to a specific gravity of 1·1—with excess of potassic dichromate. Here, again, we did not meet with immediate success, but found by experience that, if the acid in process of distillation carries with it a constant stream of chlorine, the distillate is arsenic-free. Thus the continuous evolution of chlorine is evidently the crux of the method; should this fail, the non-volatile arsenic acid in the retort might be reduced to the arsenious state by traces of organic matter, and possibly even by the hydrochloric acid itself, with consequent contamination of the distillate. As Thomson has already explained, the free chlorine in the distillate can be readily got rid of by drawing air (preferably filtered air) through the liquid.

The flask (capacity about 900 c.c.) and condenser tube used in the distillation of the acid were of Jena glass, the flask having a glass stopper and the joints being ground. The receiver was a flask made of ordinary glass, of which the neck was ground to fit the lower end of the condenser tube; it had a side tube in the neck, which was attached to a bottle containing a few sticks of potash, any nuisance from escape of chlorine into the room being thus avoided.

The purified acid was kept in large flasks of Jena glass, with glass-bulb stoppers, paper being wrapped round these to prevent ingress of dust.

Sulphuric Acid.

On several occasions we were able to obtain this acid from the dealers free from arsenic, but, as a general rule, we found it necessary to purify it in the laboratory. The Joint Committee's method (*i.e.*, distillation of ordinary pure sulphuric acid in a non-tubulated retort with a little sodium chloride, and rejection of the first portion of the distillate) was found to work easily, and we had no difficulty in obtaining the acid free from both arsenic and chlorine by means of it. The test of purity was the total absence of any mirror when 5 c.c. of the acid—diluted, of course—were "Marshed" in the ordinary way.

Nitric Acid.

This reagent was prepared by redistilling the ordinary pure acid with a little nitre and a few crystals of silver nitrate. It was tested for purity by evaporating 10 to 20 c.c. to dryness in a porcelain basin over a water bath, washing the residue into a Marsh apparatus with a little acidulated water, and "Marshing." Obtained in this way, it was invariably found to be arsenic-free.

Sulphurous Acid.

An aqueous solution of this acid was prepared, when required, by gently warming a mixture of sodium sulphite and dilute sulphuric acid, the liberated gas being passed through water to saturation. Though it was not found necessary, it would be an additional safeguard to interpose between the generating and condensing vessels an intermediate flask or Wolff's bottle, containing a very little water, in case traces of hydrochloric acid should also be evolved. The aqueous sulphurous acid thus obtained was tested by oxidising 10 to 15 c.c. with nitric acid, evaporating to dryness in a small porcelain basin over the water-bath, and Marshing the solution of the residue.

Ammonia and Carbonate of Ammonia.

We found no difficulty in obtaining aqueous ammonia arsenic-free, and the same usually applied to ammonium carbonate also. Nevertheless, more than one sample of the latter was found to be arsenical, and such samples were of course rejected. These reagents were tested for purity by evaporating about 20c.c. in a small basin on the water-bath, either to dryness or until the liquid no longer smelt of ammonia. The solution was then acidified with sulphuric acid, and Marshed either directly or after preliminary treatment with aqueous sulphurous acid.

Potassic Chlorate.

We have found no difficulty as regards this reagent. It must, of course, be tested for purity by decomposing a sufficient quantity—say 5 to 10 grammes—with a slight excess of arsenic-free hydrochloric acid (exactly as in a "Fresenius-Babo" estimation), evaporating down, reducing the residue with sulphurous acid solution, and Marshing.

Zinc.

Granulation of Zinc.

As a general rule, though not always, the "arsenic-free" zinc which we obtained from the dealers proved to be satisfactory, provided it was bought in block form (not granulated) and granulated in the laboratory as described below. For this latter purpose a small portion of a block was melted in a Berlin porcelain basin, the dross being skimmed off with a hard glass rod until the surface remained almost bright for a short time; the molten metal was then granulated by pouring it from a height of 4ft. or 5ft. into a clean vessel of glazed earthenware containing cold water. The fragments of granulated zinc to be used should be flaky and rather thin—not like buttons.

Test for Arsenic in Zinc.

3 Grammes of the zinc thus obtained were then tested for traces of arsenic by Marshing with 5 c.c. of arsenic-free sulphuric acid in about 50 c.c. of water, the experiment being continued until the zinc was practically all dissolved.

* The acid was regarded as pure if 20 c.c. of it gave no trace of a mirror when "Marshed."

Test for "Sensitiveness" of Zinc.

If the above test proved satisfactory, the "sensitiveness" of the zinc was then ascertained by making a second similar experiment, but introducing into the generating flask, after all air was expelled, a very small quantity of a solution of arsenic (say equal to 0·0025 m.grm. As_4O_6). When this small amount of added arsenic was recovered quantitatively in the mirror tube, the sample of zinc was regarded as being sufficiently sensitive to allow of its being used.

ASBESTOS.

The fibres of asbestos, used for filtering precipitates containing sulphide of arsenic, should be soft and silky. The asbestos is prepared by repeated extraction with concentrated hydrochloric acid until the extract is no longer coloured by iron; it should be washed and squeezed between each two extractions. After the last washing it is preserved in a stoppered bottle under water. It must then, of course, be tested for arsenic, when making a blank with the other *pure* reagents, by the same procedure as in an actual determination by the Fresenius-Babo method (see below).

WATER.

As the ordinary distilled water of the laboratory contained an appreciable quantity of copper, derived from the copper still and condensing tube, all the water employed in the following work was re-distilled from a glass retort.

B.—METHOD OF ESTIMATION.

See Diagram, p. 226.

After having extracted the arsenic from any given sample (which did not admit of direct Marshing), the actual estimation of this arsenic in the final solution was invariably done by the Marsh-Berzelius method as modified by the Conjoint Committee of which Mr. Hehner was chairman (Appendix No. 20). We did, indeed, try some estimations by the Reinsch method in the earlier stages of this work, but the results obtained did not appear to be so satisfactory as those given by the modified Marsh process. At the same time we did not continue the use of the Reinsch method sufficiently long to allow of our venturing to offer any opinion upon the relative merits of the two.

"MARSH" APPARATUS EMPLOYED.

The form of Marsh's apparatus used was a modification of that described by Scudder (Evidence, Vol. I., Q. 4270). It is shown in the lettered diagram I (not drawn exactly to scale) which accompanies this Report. As is well known, the main point of difference between this form of apparatus and the others more generally employed for the same purpose is that the greater part of the supply of hydrogen, other than that required for the formation of arseniuretted hydrogen, is derived from a source outside the "Marshing" flask proper, *i.e.*, from a Kipp hydrogen apparatus filled with zinc and hydrochloric acid. For some time we used in this "Kipp" (A) reagents which were termed "arsenic-free" (but were not really so), but subsequently we found this to be a needless expense, for in any case it is essential that there shall be attached to the "Kipp" an arsenic-absorption apparatus such as that described below.

In order to ensure the Kipp hydrogen being really arsenic-free before it reaches the Marsh flask, it is passed successively through (1) a red-hot tube (B) of Jena glass, about 4 to 6 m.m. internal diameter, heated by a good Bunsen burner (this, of course, effects the deposition of much of the arsenic present); (2) a small narrow glass-stoppered wash-bottle (C), of about 30 c.c. capacity, containing some strong sulphuric acid, the object of this being to absorb any traces of heavy hydrocarbons;* and (3) through two similar small wash-bottles (D) (D), of about 40 c.c. capacity each, containing a solution of silver nitrate, the second having attached to it a small tower filled with fragments of glass also moistened with the nitrate of silver. These last absorb any traces of arsenic or of sulphuretted hydrogen which may have escaped the heated tube (B).

Between the last wash-bottle and the Marsh or generating flask, there is placed a short, rather wide, capillary glass tube (F) (an idea suggested by our colleague, Mr. R. B. Floris), preceded by a small piece of pressure rubber tubing, with screw clip attached (E), which allows the flow of hydrogen to be more easily regulated than can be done by the stopcock of the "Kipp" alone. By this means the latter may be turned full on, so that the pressure of the liquid in the "Kipp" has full play. The solution of nitrate of silver in the last two wash-bottles was at first used very dilute, but it was afterwards found better to employ a somewhat strong solution. Care must, however, be taken to renew this solution frequently (the frequency, of course, depending on the volume of gas passed through the apparatus), to prevent the contingency of nitrous fumes being carried over into the generating flask, with the possible result of evolution of arseniuretted hydrogen being hindered.

The remaining or essential portion of the apparatus, that in which the actual estimation of arsenic is carried out, is in principle the same as that used by most other chemists, since its introduction by the Conjoint Committee. It consists of a small generating flask (G), to which are attached short tubes (H H), containing respectively (1) paper moistened with acetate of lead solution and air-dried, and (2) small pieces of fused calcium chloride; the last is followed by the mirror tube (I). All joints between G, H, and I are made of short pieces of pressure rubber tubing.

A detailed description of this portion of the apparatus may, however, be of interest to some readers. The "Marsh," or generating flask (G) is blown from tubing of which the bore just fits a No. 6 rubber stopper†; the bulb of the flask has a capacity of about 70 c.c., and the neck is, roughly, 9 c.m. long. The rubber stopper has three holes, through which pass (1) the tube which brings in the "Kipp" hydrogen (this tube is somewhat constricted at the lower end, which must dip under the liquid in G); (2) a long, narrow tap funnel, capable of holding 10 c.c. of liquid, which serves for the introduction into (G) of either the acid or of the liquid to be tested; and (3) an exit tube connected to the tube containing the lead acetate paper. This latter tube, which is about 3·5 to 5 c.m. long and 12 m.m. wide externally, contains a loose roll of filter paper, about 3·5 c.m. in length and 8 m.m. in thickness, which has been soaked in a solution of acetate of lead and then allowed to dry in the air. Its use—as everyone knows—is to absorb any traces of sulphuretted hydrogen which may have been formed in the generating flask. The calcium chloride tube—about the same length and width as the other—is plugged at either end with cotton or glass wool, to keep the small pieces of chloride in position; it serves to dry the gas before the latter passes into the mirror tube. The chloride of calcium in this tube should be renewed whenever the first pieces become visibly damp.

The mirror tube (Diagram II.) is made from rather thick-walled, milky Jena glass tubing of about 5 m.m. external diameter. At first we carefully cleansed this from all traces of dust, washed out with distilled water, and dried; but latterly this was dispensed with, unless the tube was obviously dusty. A piece of this tubing is thickened and drawn out over the blowpipe flame until the internal diameter of the drawn-out part is about 1 m.m., its length being about 9 to 10 c.m. It is, of course, important to keep the bore of this drawn-out portion, at the place where the arsenic mirror is deposited (A), as nearly uniform as possible. The fine end of the tube is turned up at right angles, its aperture being fused quite small, so as to prevent backward diffusion of air into the tube. The wide end (B), which is about 12 c.m. from the shoulder (C), is constricted a little, so that it may fit into the rubber pressure tubing connecting with the chloride of calcium tube, while at about the middle of this wide part (X) another slight constriction is made, to allow of the tube being fused up easily at the end of an estimation. Before use the tube is cleansed from traces of organic matter by heating to redness and drawing air through it.

* In the earlier stages of our work this sulphuric acid bottle was not used.

† This stopper and the neck of the flask are drawn rather large in the diagram for the sake of clearness. It would, of course, be preferable if the stopper and all the joints of this apparatus from the generating flask to the mirror tube were of glass throughout. In the estimation of arsenic in fuels by Dr. McGowan and Mr. Floris (Appendix, No. 23), a very tiny ring of mirror (probably antimony) was sometimes found deposited close to the flame of the mirror tube; and in case this should have been caused by the spitting of the acid in the generating flask on to the red rubber stopper (the neck of this particular generating flask being very short), the bottom of the rubber stopper in the fuel estimations was latterly coated with paraffin.

Appendix 22.

In an actual experiment the mirror tube is supported at two points on an ordinary round iron tripod, small screens of tinned iron (which anyone can make for himself) being so arranged as to protect the Bunsen burner from draughts, and also to prevent the flame from being blown on to that part of the tube at which arsenic is deposited. The fine end of the tube (D) is also held by a wooden clamp, to prevent "buckling" while an estimation is in progress. The tube is heated to bright redness at E by means of a good, but small, Bunsen burner, the flame covering about 2c.m. of the wide part of the tube (including the shoulder).

Advantages and Disadvantages of the above Apparatus.

It may be well at this point to sum up shortly the main advantages and disadvantages of the above form of "Marsh" apparatus, as compared with other forms in general use.

Advantages.

1. A small generating flask can be used, because of the small quantities of reagents employed.

2. There is great economy in the use of these arsenic-free reagents, a consideration of moment when the frequent difficulty of preparing them pure is borne in mind.

3. The "washing-out" of the apparatus with hydrogen before and after an estimation can be done easily and rapidly.

4. The rate of flow of hydrogen can be very easily regulated and maintained constant throughout an estimation.

Disadvantages.

1. The slow bubbling of the "Kipp" hydrogen through the liquid in the generating flask causes the deposition of "double" mirrors; in other words, in the portion of the capillary tube where the arsenic is deposited there are two regions, one in front of the other. This of itself might be thought a fatal objection by many people, on the ground that it is less easy to read a double than a single mirror with accuracy; and there can be no doubt that a perfectly valid objection can be made on this score, for a single mirror is clearly better for quantitative reading than a double one. We have found, however, that with standards prepared in the same way as the mirrors in the actual estimations, the differences in a large number of readings made over a long period by both of us independently were almost invariably very slight.

2. The apparatus takes up much more room than most other forms. With a suitable arrangement of T tubes, however, this objection can be to a great extent overcome, one "Kipp" and one purifying apparatus being sufficient to serve several generating flasks.

Method of Working the Apparatus.

The portion of the apparatus dealing with the purification of the Kipp hydrogen having been fitted up and the hydrogen turned on, 3 grms. of zinc and about 30 c.c. of water are introduced into the generating flask. The complete apparatus—with the exception of the mirror tube—is now connected up, and the Kipp hydrogen allowed to flow through it for 10 minutes or so, at the rate of about four small bubbles per second. The mirror tube is then attached and the flow of hydrogen continued for another five minutes, after which the Bunsen burner under the mirror tube is lighted. If after a further period of 10 minutes the tube is still perfectly clean, the hydrogen is slowed down to the rate of about one small bubble per second, the diluted acid (10 c.c. of 1 in 4 sulphuric acid, or 10 c.c. of hydrochloric acid of 1·1 sp. gr., as the case may be) run into the generating flask, and another "blank" of 10 minutes performed. Should there still be no sign of any deposit in the mirror tube, the solution to be tested is run into the generating flask, and the experiment continued for at least an hour longer, by which time the whole of the arsenic present will have been deposited in the mirror tube. The rate of flow of the Kipp hydrogen is now slightly quickened for a few minutes, and the mirror tube fused off at X and then immediately at E (see Diagram II. above), labelled, and read against standards prepared in the same manner. The volume of liquid in the generating flask is always kept as uniform as possible, *i.e.*, at about 50 c.c.; and, if the flask should show any tendency to become warm, it is immersed in cold water.

Preparation of Standard Mirrors.

For this purpose a standard solution of arsenious oxide in water was made by dissolving an accurately weighed quantity (about 0·3 grm.) of the pure dry powdered substance in 500 c.c. of water. After our first experiments the arsenious oxide was recrystallised beforehand from a hydrochloric acid solution, washed and dried; it left no residue on being vaporised. As is well known, a little time and patience is required to prepare an aqueous solution of even such a small quantity of arsenic as that given above. The solution thus obtained was made up to 500 c.c., and the amount of arsenic in it checked by titration with a standard solution of iodine. To instance one case:—0·3008 grm. arsenious oxide was dissolved in water, and the solution made up to 500 c.c. 1 c.c. therefore contained theoretically 0·000602 grm. As_4O_6. By titration with iodine the strength came out at 0·000577 grm.

From the above strong arsenical solution, dilute solutions were made as required; for, while the strong solution keeps its strength for a long time, perhaps indefinitely, a dilute solution has been found by some observers to weaken rather rapidly.

Standard tubes of the following "densities" were made (and renewed from time to time as required):—

0·0025	m.grm.	As_4O_6
0·0035	,,	,,
0·005	,,	,,
0·010	,,	,,
0·015	,,	,,
0·020	,,	,,
0·025	,,	,,
0·030	,,	,,
0·040	,,	,,

Corresponding sets of tubes were prepared both with sulphuric and with hydrochloric acid (for comparison respectively with "Marsh" estimations done with the one or the other acid), but we found very little, if any, difference between the densities of the mirrors produced with equal amounts of arsenic by these two acids.

The mirror which we found it most convenient to read was that given by 0·01 m.grm. of arsenious oxide; we therefore endeavoured, as far as possible, to adjust the quantity of extract Marshed so as to yield a mirror approximating to this in value. But in many cases, of course, the mirror which had to be read was much smaller, while in a considerable number of instances it was, from one cause or another, denser.

C—METHODS EMPLOYED FOR THE EXTRACTION OF ARSENIC FROM DIFFERENT SUBSTANCES BEFORE "MARSHING."

In this connection we should like to take the opportunity here of expressing our indebtedness more especially to Professor Wormley's excellent book on the "Micro-Chemistry of Poisons," from which we have derived much useful information and guidance.

Four different general methods, sometimes more or less modified according to the circumstances of the case, have been employed, viz.:—

(1) Direct Marshing, without destruction of organic matter,

(2) Marshing of the final extract after preliminary destruction of the organic matter by—

(a) The *Fresenius-Babo* method, with chlorate of potash and hydrochloric acid;

(b) *Gautier's* method, with nitric and sulphuric acids;

(c) The basic method of *Newlands* and *Ling*, with the use of lime and lime-water.

Blanks.—It should be added here that blank experiments with all the reagents and vessels used in the estimations were carried out, and, in doing these "blanks," the procedure and also the time occupied were as nearly as possible the same as in the actual

experiments themselves. This point is obviously of supreme importance when *post-mortem* cases are in question.

DIRECT "MARSHING," WITHOUT PREVIOUS DESTRUCTION OF ORGANIC MATTER (IF PRESENT).

Only a comparatively few samples, such as waters, sugars, the hydrochloric acid extracts of whole rice, and the constituents of effervescing drinks, were Marshed directly, as a rule, with hydrochloric acid, without previous destruction of the organic matter, if present. When it was necessary—as in the case of sugars—a larger generating flask than usual was employed (a flask of about 200 c.c. capacity), together with larger quantities of zinc and acid; but in the first instance it was ascertained by experiment that the use of this larger apparatus did not influence (at all events, appreciably) the "density" of the mirror produced by a given quantity of arsenic.

In the case of *sugars*, 10 grammes of the sample were taken, and the solution run gradually into the generating flask, so as to avoid any danger from frothing. The Marshing was continued for from 30 to 40 minutes after the addition of the sugar solution, more acid being added if required.

In the case of samples of *whole rice*, the method followed was that recommended for malt by the Joint Committee of the Society of Chemical Industry and of the Society of Public Analysts, viz., to digest 50 grammes of the substance with a mixture of 50 c.c. water and 50 c.c. hydrochloric acid of 1·1 sp. gr. at a temperature of about 50° C. for 15 minutes, and to Marsh a portion of the decanted extract. This treatment does not make the rice spongy, but rather granular, and, as it is not continued for a long period, the probabilities are against any appreciable absorption of arsenic from the acid solution by the grains of rice themselves. No water being subsequently added, 10 c.c. of the above extract correspond to 5 grammes of rice. In order to see whether any arsenic was kept back in the generating flask by the organic matter in solution or semi-solution in the hydrochloric acid extract, this organic matter was destroyed in a portion of one such extract, and the final inorganic solution Marshed; the results obtained showed that no arsenic had been kept back by Marshing the liquid directly.

Malt Extracts were also Marshed directly. Here again, in one case, practically identical results were obtained (a) by direct Marshing, and (b) by preliminary destruction of the organic matter with nitric and sulphuric acids.

We should, however, like to add here, in conclusion, that it must not be assumed without actual proof that direct Marshing is sufficient to extract the arsenic present in any substance, otherwise serious error may result (*cf.* samples of *Apple Green* and *Baking Powder* in Tables of Analysis, Appendix 25).

DESTRUCTION OF ORGANIC MATTER PRELIMINARY TO "MARSHING."

As already stated, one of three general methods was followed here, according to the nature of the substance under examination. It must, however, be borne in mind, when reading the details given below, that the methods were slightly modified in some instances. No hard and fast rule with regard to this can be laid down, much depending on the common sense of the operator.

(*a*) *The Fresenius-Babo method, i.e., destruction of organic matter by chlorate of potash and hydrochloric acid.*

This well-known and well-proved method is particularly applicable to those cases where a large weight of substance has to be treated, e.g., viscera, dried fish, etc., but it also answers equally well with smaller weights of such substances as hair. Gelatine and allied bodies, too, readily pass into a state of limpid solution when warmed with hydrochloric acid and a little chlorate of potash, and these latter solutions can, after reduction, either be Marshed directly or precipitated in the first instance by sulphuretted hydrogen, as described below. The chlorate method of destruction of organic matter is thus perhaps of more general application than any other. Its great disadvantage must always be the length of time which is required for carrying it out—not much less than five days; and, besides this, the number of points which require to be observed in its manipulation are considerable, so that some practice is necessary before accurate results can be achieved. In spite of these drawbacks, however, we—like others who have carefully examined this method—have found it invaluable where small quantities of arsenic have had to be extracted from large weights of material (test experiments under those conditions having shown that it can be made to yield good results). Appendix 22.

The following are the details of the method:—

In the case of fresh viscera a convenient weight to take for examination is about 150 grammes; of dried fish not more than 30 to 40 grammes should be used; 12 grammes of hair (if obtainable) is a suitable quantity; while about 20 grammes of gelatine may be taken. In every case the substance in question is cut into as small pieces as possible and treated in a basin of Berlin porcelain with 20 to 70 c.c. hydrochloric acid of 1·1 spec. grav. (according to the weight taken), mixed with about three times its volume of water. After being well stirred, the whole is warmed over a low rose-burner flame almost, but not quite, to boiling. Small quantities of pure chlorate of potassium (about one-third of a gramme at a time) are now added at intervals of a few minutes, care being taken to keep the volume of the liquid constant by the addition of a little water from time to time. By this treatment the whole of the solid gradually goes into solution, and the liquid assumes a yellow colour. The addition of chlorate is continued until the yellow ceases to change to brown in about ten minutes, after which the liquid is further warmed till it just begins to darken in colour, an indication that all the chlorate has been decomposed. The liquid is now allowed to become quite cold, when a considerable quantity of solid matter separates out, after which the clear supernatant liquor is poured on to a filter of Swedish filter paper, and the residue in the basin washed two or three times by being warmed with water and a little hydrochloric acid, cooled and filtered. It is important that the liquid should be quite cold before filtration (ice being used for cooling, if necessary), otherwise the filtrate will deposit more solid matter and will require filtration a second time. The mixed filtrate and washings are now returned to the porcelain basin and evaporated slowly over a small rose-burner flame to a volume of about 200 c.c., one or two further crystals of chlorate being dropped in from time to time, should the liquid again tend to become dark coloured. After this evaporation it is allowed to cool somewhat, and 10 to 15 c.c. of a saturated aqueous solution of sulphurous acid are added, in order to reduce the arsenic to the arsenious condition. The liquid is now allowed to stand for some time and then the sulphurous acid is cautiously steamed* off, care being, of course, taken that the hydrochloric acid present never becomes at all concentrated, otherwise arsenic will be lost as trichloride.

The residual liquid, whose volume—assuming that 70 c.c. of 20 per cent. hydrochloric acid were originally taken—should be rather less than 200 c.c. but not less than 150 c.c., is now cooled and filtered, if necessary, into a conical flask of Jena glass of about 200 c.c. capacity. A slow current of washed sulphuretted hydrogen is then passed through the liquid for an hour, the flask (which is nearly full) tightly corked† and put on the top of an incubator or some other moderately warm place until next day, when more sulphuretted hydrogen is passed into it, and the flask again corked. If after two days more the liquid still smells of sulphuretted hydrogen, it is filtered through purified asbestos in a Gooch crucible, the precipitate being washed with a little sulphuretted hydrogen water. It is important that the volume of this wash water should not be great, say, not more than 20 c.c., otherwise sulphide of arsenic, if present, is liable to assume the colloidal form and to pass through the filter.

The asbestos containing the washed precipitate is then transferred from the crucible to a small porcelain basin, the crucible being finally rinsed out with a little water. After warming the basin on a water-bath to disintegrate the asbestos, 2·5 c.c. of (1 in 5) aqueous ammonia are added, the warming continued for a short time, and the dark-coloured liquid poured from the asbestos on to a small (Swedish) filter; and this extraction with small quantities of ammonia and water is continued until both the asbestos and the filtrate are

* The expression "steaming" is sometimes used in the course of this paper. It merely means evaporating quietly, not boiling.

† A softened cork, covered at bottom and sides with a piece of filter paper, makes a clean stopper.

Appendix 22.

colourless. The whole of the arsenic is now in the filtrate. This is evaporated on a water bath to dryness, or, at least, until the whole of the ammonia is expelled ; 2 c.c. of concentrated nitric acid are added to the residue, and digestion is continued on the water bath, with subsequent small additions of nitric acid, if necessary (not less than 1c.c. at a time), until the liquid is pale yellow in colour. The free nitric acid is then evaporated off, or practically so, and the residue extracted about three times with a few c.c. of a warm aqueous solution of ammonium carbonate (1 in 4), in order to get rid of any sulphur which may have been deposited in the course of the treatment with nitric acid. After again filtering, the liquid is evaporated on the water bath until free from ammonia, and the residue again treated with nitric acid and evaporated to dryness. Then a very little concentrated sulphuric acid, say 8 to 10 drops, is added and the basin heated until the contents are thoroughly charred, when the excess of sulphuric acid is driven off with the precautions to be afterwards described under Gautier's method below. The subsequent treatment, *i.e.*, extraction of the char with acidulated water, reduction of the extract with aqueous sulphurous acid, etc., are exactly the same as given under Gautier's procedure, to which the reader is therefore referred.

Note.—The remarks made under Gautier's method with regard to ignition of the final nitric acid residue with lime apply, of course, equally here also.

In conclusion, as has been already stated, some knowledge of the various points of this method—knowledge which can only be gained by practical experience—is essential before accurate results can be obtained by it. But, given that experience, we have every reason to rely confidently upon it.

As has been already stated, the mirrors obtained by the foregoing Fresenius-Babo method (which includes precipitation with sulphuretted hydrogen) were read against standard tubes prepared by the direct Marshing of an arsenic solution. The work on fuels done for the Commission (McGowan and Floris, Appendix X.) has shown that it is inadmissible to compare a mirror obtained from the precipitation of arsenic in an *inorganic* solution with a directly Marshed standard; sulphide of arsenic not being altogether insoluble, the results from such a comparison come out too low. The fuel mirrors were, therefore, read against standards obtained by precipitating known quantities of arsenic as sulphide, and working up the precipitate exactly as in the estimation itself.

Possibly the results given by the Fresenius-Babo method may tend for this reason to be a little low also, though the error cannot be very great here, because the precipitate of sulphide of arsenic always brings down with it very considerable quantities of organic matter, which no doubt have an absorptive and precipitating effect upon arsenic which would otherwise remain in solution. In an early test experiment, in which 0·05 m.grm. of arsenic was added to 100 grms. of moderately fat beef (finely cut up), the mixture being then chlorated, etc., practically the whole of this arsenic was recovered (a "blank" was done at the same time). To really test the point properly would have required estimations to be made with known amounts of arsenic mixed with a large variety of arsenic-free foods or other organic substances, similar in nature to those actually under examination.

(b) *Gautier's Method, i.e., the destruction of organic matter by nitric and sulphuric acids together.*

Briefly described, this method consists in first partially destroying the organic matter by oxidation with concentrated nitric acid, then charring the residue with concentrated sulphuric acid, driving off the excess of the latter, and extracting the thoroughly charred residue with acidulated water. The whole of the arsenic originally present should be obtained in the extract.

The method can, if necessary, be employed for the extraction of arsenic from large quantities of flesh, etc., but it is more suitable where smaller quantities—say, 5 to 10 grms.—of vegetable substances, such as flour, chicory, malt extract, etc., have to be dealt with. We have found it especially useful with the following classes of substances:—(*a*) Mixtures containing considerable quantities of cellulose—a substance which is not attacked by chlorine, and which may possibly, therefore, be liable to act as an absorbent (or adsorbent) sponge if left undestroyed; (*b*) *broken* cereal grains, to which the other methods could not conveniently be applied ; (*c*) organic and inorganic colouring matters.

Process.—The substance in question is first treated with about 5 c.c. of pure concentrated nitric acid in the cold, the basin being afterwards warmed very cautiously on a water bath. After the tendency to froth has ceased, this warming may be done more strongly, and further small quantities of nitric acid added from time to time until the whole of the substance has gone into solution. The heating of the basin is then continued over a low rose-burner flame or, preferably, a *dry** water bath, until the mass is semi-solid, when 1 c.c. of concentrated sulphuric acid is added, and the gentle heating renewed until the whole has become black, at which stage an ordinary Bunsen flame is substituted, in order to drive off all excess of sulphuric acid. This latter operation must be performed very cautiously, and great care must be taken to ensure that no part of the basin approaches a red heat. If the smell of sulphurous acid can be detected in the escaping fumes, the heating must be stopped and the contents of the basin again treated with nitric acid, as described above. When all the sulphuric acid has been driven off, the charred residue —which is dry, and easily pulverised—is extracted several times with small quantities of acidulated water (acidulated preferably with sulphuric acid) and filtered. To the filtrate, which must be clear, colourless, and without smell, a few drops of aqueous sulphurous acid solution are then added; after the excess of the latter has been gradually steamed off, the liquid is ready for Marshing.

That this method is accurate when properly worked, we have no doubt. In one test experiment—a severe one—0·05 m.grm. of arsenious oxide was added to 100 grammes of fat beef, which was then treated as described above. Although the large bulk of the material made it difficult to handle properly, 0·043 m.grm., or nearly 90 per cent. of the arsenic was recovered in the final extract. ("Blanks" were, of course, also done, to ensure the purity, etc., of the re-agents employed).

The point at which there is danger of losing arsenic is in the expulsion of the excess of sulphuric acid. If part of the latter were reduced to sulphurous acid, that in its turn would reduce arsenic to arsenious acid, which would be volatilised at the comparatively high temperature employed. The only way to avoid this is to get rid of the sulphuric acid as rapidly as possible without overheating the basin. Should overheating occur, the arsenic acid present may be decomposed and the arsenic volatilised; this, however, is not likely to take place if the basin is kept well below a red heat. The point is one in which experience is the best guide.

Care must also be taken to get rid of the *whole* of the sulphuric acid before extracting the residue. If this be not done, the extract will be turbid and coloured, and a large quantity of sulphuretted hydrogen will afterwards be liberated in the Marsh apparatus. This point, *i.e.*, the necessity of having a solution to "Marsh" which is quite free from organic matter, has also been emphasised by Bertrand (*Bull. Soc. Chem.*, Series 3, Vol. XXVII., No. 16).

Suggested Simplification of Gautier's Method.

In conclusion, we would suggest that this method of Gautier might be modified by conjoining it with the Basic Method in the following manner. After the organic matter has been disintegrated by treatment with nitric acid, as already described, the residue—instead of being charred by sulphuric acid—might be thoroughly mixed with an excess of lime and lime water, and, after drying, be incinerated. The lime residue could then be brought into solution and (in the absence of any appreciable quantity of iron†) be Marshed directly. We have tried this method with two samples, but have not had time to test it with known quantities of added arsenic. We have no doubt, however, from a considerable experience of the basic method in other directions, that it would be found to yield satisfactory results, as the combustion is a very easy one; it would also effect a considerable saving of time.

* For this purpose a small enamelled basin fitted with copper rings is employed.

† McGowan and Floris.—Report on the Methods employed in the Examination of Fuel Samples for the Commission (Appendix, No. 23, below).

(c) The Basic Method (Newlands and Ling: Chapman).

This method, of which two modifications for the estimation of arsenic in fuel were recently introduced independently by Newlands and Ling[1] and by Chapman[2], is now well known. We have employed the method of Newlands and Ling, modified sometimes by the use of lime water in addition to lime, as recommended by the Committee appointed by the Commissioners of Inland Revenue[3], and have found it useful in the following cases:—(*a*) Starchy substances, such as broken cereal grains, flour, meal and malt; (*b*) organic colouring materials like "apple green," "carmine," etc.; (*c*) inorganic colouring matters, such as Bole Armenia, which consists mainly of oxide of iron (in such a case the arsenic must be precipitated with sulphuretted hydrogen from the lime extract, to get rid of this iron before Marshing); (*d*) substances like cigarette papers, which consist mainly of cellulose. Many of these would be difficult to treat in a satisfactory manner by other methods. Thus, cellulose is not attacked by chlorine, and nitric acid might form an explosive derivative with it; again, resistant inorganic colouring matters would be hard to treat in any other way than by ignition with a base.

The method usually followed with organic mixtures was to first moisten the substance thoroughly with lime water, and, after evaporating off the water on a water-bath, to mix with powdered lime and then ignite at a red heat in a platinum basin. When the residue became white, it was extracted (dissolved, if possible) with dilute hydrochloric acid, and, if the resulting solution did not contain any appreciable quantity of iron, it was Marshed directly, after steaming, to get rid of carbonic acid. If, on the other hand, iron was present, the extract (filtered, if necessary) was poured into a conical flask of 150 c.c. capacity, and 5 to 10 c.c. of a saturated solution of sulphurous acid were added. The neck of the flask being then covered with filter paper to keep out the dust, it was placed on the top of a hot bath oven overnight. By next morning the sulphurous acid had either been absorbed or had evaporated, when the liquid was saturated with sulphuretted hydrogen. The sulphide precipitate was ultimately worked up as has been described under the chlorate method, the only difference being that, owing to absence of organic matter here, there was no need to carry the process further than evaporation with nitric acid of the residue from the ammoniacal extract of the precipitate. This final residue, after reduction with sulphurous acid, was then Marshed.

Strictly speaking, the mirrors obtained from substances treated by the basic method, conjoined with subsequent precipitation by sulphuretted hydrogen, should have been compared with special standards obtained in exactly the same way (*i.e.*, not with the ordinary standards got by the direct Marshing of definite quantities of arsenic solution). But since only a very few samples would come into question here—probably only Nos. 45 (Bole Armenia), 47 (Coffee Colour), and 48 ("Saster")—the results are not materially affected.

GEORGE McGOWAN.
R. S. FINLOW.

Ealing, June, 1903.

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(1) *Journal of the Federated Institutes of Brewing*, Vol. VII., No. 4, p. 314.
(2) *Analyst*, Vol. XXVI., p. 253.
(3) *Appendix, No. 21.*

Appendix 22

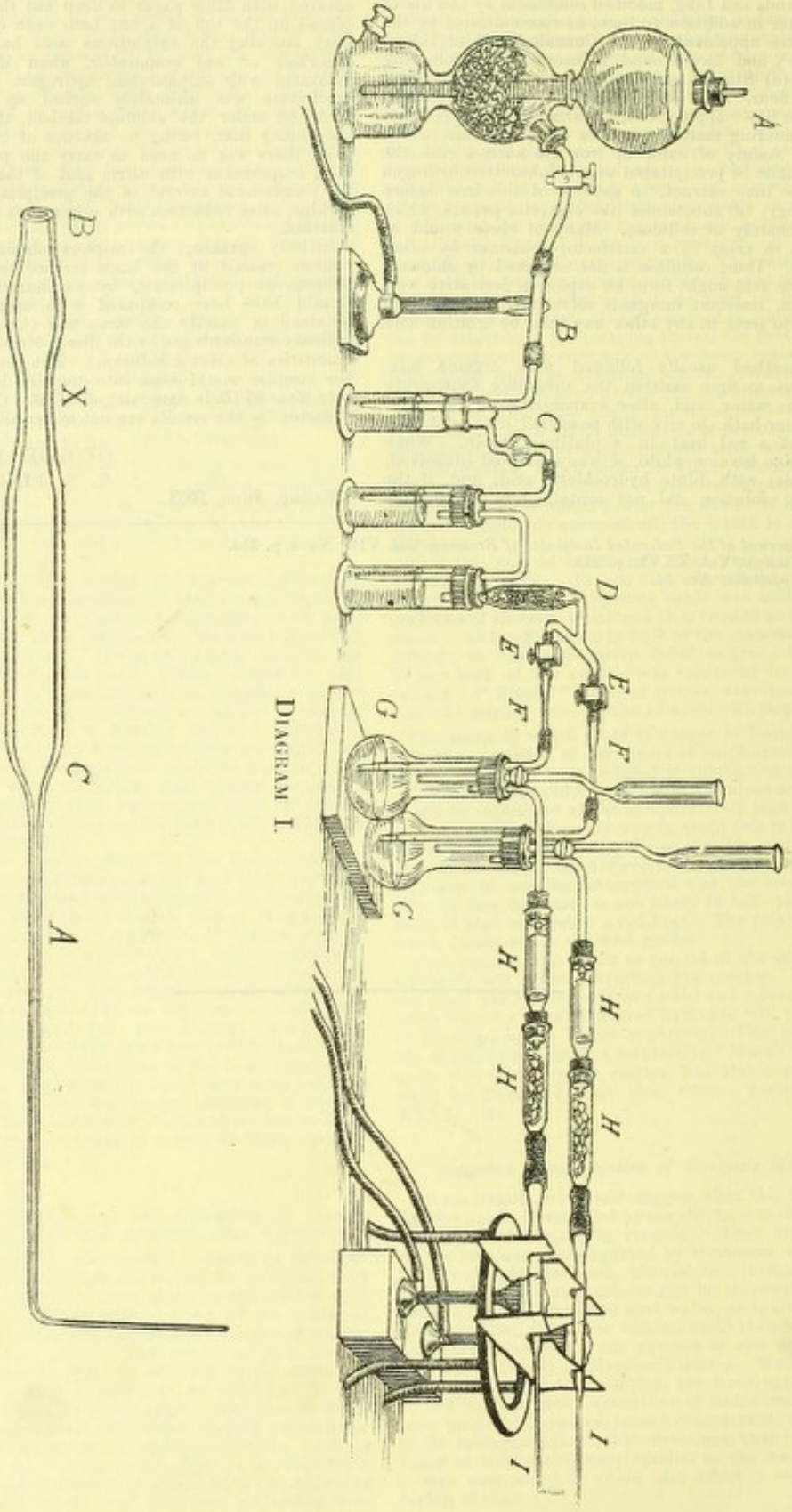

DIAGRAM I.

DIAGRAM II.

APPENDIX 23.

TESTS FOR ARSENIC IN FUEL.

REPORT BY DR. G. McGOWAN AND MR. R. B. FLORIS ON EXPERIMENTAL WORK DONE IN CONNECTION WITH THE ESTIMATION OF ARSENIC IN FUEL, AND METHODS EMPLOYED IN THE EXAMINATION OF FUEL SAMPLES FOR THE COMMISSION.

In the course of making analyses of fuel for the Royal Commission on Arsenical Poisoning by the method of Newlands and Ling, it became apparent that the whole of the arsenic could not always be estimated by the Marsh-Berzelius method, when the residue after ignition with or without lime was dissolved in aqueous hydrochloric acid and "Marshed" directly. For it was found that, when using this method, the "non-volatile arsenic" was estimated in several cases as considerably in excess of the "total arsenic," and it was further notable that this contradictory result was obtained most markedly with a residue rich in iron, the latter thus appearing to be the disturbing factor in the analysis.

Attempts, shortly summarised below, were therefore made to obtain the true arsenic values, without having recourse to the rather lengthy process of separating the arsenic from the iron before estimating the former by the Marsh method.

It was found repeatedly that when a minute quantity of arsenious oxide was mixed with a large excess of arsenic-free lime, and the whole ignited in a platinum basin over a hot Bunsen flame for 2 to 3 hours (*i.e.*, for as long a time as would be required to burn off all carbonaceous matter in an actual estimation of arsenic in a coal), the whole of the arsenic was recovered from the residue by dissolving the latter in hydrochloric acid and Marshing the solution. It was thus evident that even when arsenious oxide was heated with lime for the above length of time to bright redness, no arsenic was lost in the process, and, further, that the presence of calcium chloride and even of the traces of iron invariably occurring in lime prepared with limestone or marble did not prevent the production of a mirror of theoretical density.

A number of comparative estimations were then made with the addition of different quantities of ferrous and ferric chloride respectively, in order to ascertain to what extent their presence vitiated the results.

The iron salt was purified from arsenic as completely as possible by zinc and hydrochloric acid, oxidised to the ferric state with nitric acid, the solution evaporated and the residue ignited; the latter was then dissolved, practically in its entirety, in aqueous hydrochloric acid (the solution now contained zinc as well as iron).

The above solution of iron salt, so purified, gave no trace of a mirror when a quantity of it containing 0·5 gramme of ferric chloride in about 50 c.c. of liquid was Marshed; but, as subsequent experiments showed that ferric chloride can hold back arsenic in the Marsh apparatus, this did not constitute sufficient evidence that the purified salt might not still contain traces of arsenic. The proportion of arsenic—if present—however, was almost certainly less than the equivalent of what may be termed the "Marsh saturation point" of the iron salt as regards arsenic. This last may safely be inferred, because, were the iron saturated with arsenic as regards the Marsh test, or, in other words, were the maximum amount of arsenic which the iron present could hold back in the Marsh test already there, the quantitative recovery of (subsequently added) arsenic would not be hindered by this iron. It will be seen, however, from the experiments quoted below, that the iron did actually exert a very marked effect.

To the purified ferric chloride, known quantities of arsenious or arsenic oxide were added, and it was found in twelve experiments, with but one exception, that the amount of arsenic recovered by the Marsh method was considerably less than that taken, as is shown by the results given in the appended Table A. The "Marsh" was in every case done with hydrochloric acid (not sulphuric), and in several instances lime was added, in order to approximate the conditions to those obtaining in an actual estimation of arsenic in fuel.

TABLE A.

Arsenic taken, expressed as arsenious oxide.	Form in which the arsenic was taken, *i.e.*, whether as arsenious or arsenic oxide.	Lime added.	Ferric chloride added.	Reduced or not by aqueous sulphurous acid after the addition of ferric chloride.	Arsenious oxide recovered by the Marsh test.	Per cent. of arsenious oxide not recovered, *i.e.*, loss.
Grams.		*Grams.*	*Grams.*		*Grams.*	
0·00001	Arsenious	2·5	0·1	Not reduced	0·000005	50
0·00001	„	2·5	0·1	Reduced	0·000004	60
0·00001	„	—	—	Not reduced	0·00001	—
0·00001	„	—	0·5	„	0·00001	—
0·00001	„	—		„	0·00001	
0·00001	Arsenic	—	0·25	„	0·000003	70
0·00001	„	—	0·25	„	0·000003	70
0·00001	Arsenious	—	0·125	„	0·0000085	15
0·00001	„	—	0·125	„	0·0000065	35
0·00001	„	2·0	0·125	„	0·000007	30
0·00001	„	2·5	0·1	„	0·000005	50
0·00001	„	2·5	0·1	Reduced	0·000004	60
0·00001	„	—	0·1	„	0·0000025	75
0·00001	„	2·0	—	Not reduced	0·00001	—
0·00001	„	2·0	0·125	„	0·000007	30

Appendix 23.

The foregoing results rather negative the "saturation" theory, and seem to indicate the precipitation by the iron of varying amounts of arsenic in an insoluble form. It is difficult to see how a solution of an iron salt, which contains considerable traces of arsenic, can be purified beyond its saturation point by zinc and hydrochloric acid, and can subsequently absorb a further quantity of arsenic while these same reagents are acting upon it.

An attempt was now made to separate the iron, by precipitation, from a solution containing arsenious oxide, ferric chloride and calcium chloride, of such strength as would be obtained by dissolving in hydrochloric acid the ignited lime residue from an estimation of "total arsenic" in coal. For this purpose an excess of alkali was employed, in one case lime in the solid state being used, and in another a solution of caustic potash.* After the precipitated hydroxide of iron had been filtered off, the filtrate was "Marshed," and in both cases was found to be free from arsenic, the whole of the latter having been carried down in the iron precipitate. On dissolving in hydrochloric acid the above precipitate obtained with lime, 80 per cent. of the added arsenic was recovered in the Marsh apparatus.

It was found that after igniting ·000012 gramme of arsenious oxide with lime and extracting the residue with sulphuric acid, the whole of the arsenic was recovered from the filtered solution upon Marshing. It seemed worth while, therefore, to try the effect of adding to the solution containing iron a salt of some other metal with which the iron present would form a couple rather than with the arsenic, and so enable direct Marshing to be carried out with sulphuric acid. Copper sulphate, the use of which has been recommended by various experimenters, was therefore taken; but, as will be seen by a reference to the results given in Table B, it was not found to work satisfactorily under conditions approximating to those in the actual estimation of arsenic in a coal.

TABLE B.

Arsenic taken expressed as arsenious oxide.	Form in which the arsenic was taken, *i.e.*, whether as arsenious or arsenic oxide.	Heated with lime or not.	Ferric sulphate added.	Copper sulphate added.	Reduced or not by aqueous sulphurous acid before addition of the copper.	Arsenic, expressed as arsenious oxide, recovered by Marsh.	Percentage not recovered, *i.e.*, loss.
Grams.		*Grams.*	*Grams.*	*Grams.*		*Grams.*	
0·00001	Arsenious	—	0·12	0·0013	—	0·00001	—
0·00001	„	—	0·12	0·0013	—	0·00001	—
0·00001	„	—	0·12	0·0013	—	0·00001	
0·00001	„	—	0·12	0·0013	—	0·00001	
0·00001	Arsenic	—	0·12	0·0013	Reduced	0·000006	40
0·00001	„	—	0·12	0·0013	—	0·000006	40
0·00001	„	—	0·12	0·0013	Reduced	0·000006	40
0·000012†	Arsenious	0·60	—	—	—	0·000012	—
0·000012†	„	0·60	0·12	0·0013	Reduced	0·000003	70
0·000012†	„	0·60	0·12	0·0013	„	0·000003	70
0·000012†	„	0·60	0·12	—	„	0·0000035	63

† Ignited 0·00006 gram arsenious oxide with 3 grams of lime, extracted with sulphuric acid and took one-fifth of filtrate for each of these four estimations.

The foregoing table shows that the arsenic was duly recovered (*i.e.*, the results were quantitative) when the solution taken contained arsenious oxide, ferric sulphate and a little copper sulphate; but with arsenic oxide (whether or not the arsenic and iron had first been reduced by sulphurous acid before the addition of copper salt), some arsenic was kept back, *i.e.* the results were low. Further, where, in addition to the sulphates of iron and copper, calcium sulphate was present in solution—a condition which is unavoidable in such an extract of lime in dilute sulphuric acid—no more than 30 per cent. to 35 per cent. of the arsenic taken was (after reduction with sulphurous acid) recovered in the Marsh apparatus. We are at a loss to explain this last result.

The above investigation having occupied rather too large a proportion of the time fixed for the completion of the analyses, it appeared better to discontinue the research (although many points still remained obscure), and to proceed at once with the method of separation of arsenic by a *preliminary precipitation as sulphide* from the solution obtained by dissolving in hydrochloric acid the residues from ignition of the coal, alone and after admixture with lime.

The following is the method which we have therefore followed in dealing with the samples of fuel collected by the Commission.

The entire sample is roughly broken with a hammer, mixed and halved; one-half of this is again broken, mixed and halved, and the process is repeated a third time. Of this last sample one-half or one-quarter is broken up with the hammer between sheets of glazed brown paper on a wooden block, until no pieces are left of larger diameter than about ¼ inch; it is then carefully and successively mixed and halved until only about 50 grammes remain. From this final sample the amount required for the analysis is ground in two or three stages in Wedgewood mortars to an almost impalpable powder. The inside of the bottles in which the final sample is kept should be examined carefully, in order to ensure that there are no loosely adherent flakes of glass.

Total Arsenic.

For the determination of "total arsenic" a weighed quantity of the finely powdered coal—from 1 to 10 grammes—is mixed with 3 grammes of arsenic-free lime and ignited in a platinum basin at a bright red heat over a strong Bunsen flame, until the ash shows only the red-brown colour of oxide of iron and there are no obvious black specks left in it; this usually takes about three hours, more or less. After cooling, the residue is cautiously slaked with water and treated with about 5 c.c. of dilute arsenic-free nitric acid (1 in 10), dried on the water bath, and re-ignited for a short time to decompose any nitrate that has been formed. The entire mass is now dissolved in excess of arsenic-free hydrochloric acid (the excess amounting to about

* This potash contained a minute trace of arsenic.

10 c.c. of 20 per cent. acid) the solution diluted with water, and gently warmed for some time. It is then filtered through Swedish filter paper, the iron and arsenic in the filtrate reduced, with excess of aqueous sulphurous acid, and the excess of the latter steamed* or boiled off very gently. After this sulphuretted hydrogen is passed to saturation through the cold liquid, which has a volume of about 70 cc., and is contained in a small conical flask of Jena glass of 100 c.c. capacity; the flask is then tightly corked, allowed to stand until the precipitate has settled, and, if not still smelling strongly of sulphuretted hydrogen, it is re-saturated from time to time.

The precipitate is then filtered through asbestos in a small Gooch crucible, and washed first with sulphuretted hydrogen water until free from chlorides, and then in succession with alcohol, carbon bisulphide and alcohol again. The entire contents of the "Gooch" are now transferred to a small porcelain basin and extracted three times with about 5 c.c. of dilute aqueous ammonia (1 in 4), the extract being, of course, filtered from the insoluble matter each time.

The entire filtrate and washings are then evaporated to dryness on the water-bath, and the residue so obtained treated three times with a very little concentrated arsenic-free nitric acid (about 1 c.c. at a time), the contents of the basin being brought down to dryness after each addition of acid. The last-mentioned residue is finally extracted three times with a few c.c.'s of dilute aqueous ammonium carbonate (1 in 10), the extract being if necessary filtered; the ammonia is then got rid of on the water-bath and the arsenic in the liquid reduced with excess of aqueous sulphurous acid, the excess of the latter being steamed off as before. This final solution is then made up to a given volume, and a suitable portion—usually one-half—is Marshed with 3 grammes of zinc and 2·5 c.c. of sulphuric acid (previously diluted), the total volume of liquid in the "Marshing" flask not exceeding, as a rule, 40 to 50 c.c.

Non-Volatile or "Fixed" Arsenic.

For the estimation of "non-volatile arsenic" an exactly similar procedure is adopted, excepting that the ignition is done without lime.

* The foregoing method for the estimation of arsenic in coal has also been carefully tested by us, as previously by Messrs. Newlands and Ling, upon an artificial mixture of pure coal with a little arsenical pyrites, the amount of arsenic in this pyrites being determined by its conversion into magnesium-ammonium arseniate. Duplicate estimations (from the same solution of decomposed pyrites) gave (*a*) 27·98 per cent., and (*b*) 27·95 per cent. of metallic arsenic, the mean of these being equivalent to 36·91 per cent. arsenious oxide. Appendix 23.

·045 Gramme of the above pyrites was ignited with 3 grammes of lime and 2 grammes of a fairly pure coal, containing the equivalent of 0·0002 per cent. of arsenious oxide, the total addition of arsenious oxide from the coal being thus only 0·000004 gramme. The ash resulting from the ignition was dissolved in excess of hydrochloric acid, the solution made up to 150 c.c., and two separate portions of 1·5 and 3 c.c. of this were precipitated with sulphuretted hydrogen, the respective precipitates being treated exactly as described above in the method for "total arsenic" estimation. From the smaller quantity precipitated, an amount of final solution calculated as equal to 0·00001 gramme of arsenious oxide was Marshed and it gave a mirror equivalent to 0·0000095 gramme. From the final solution of the second precipitate a quantity calculated as equal to 0·00002 gramme of arsenious oxide was taken for Marshing, a mirror being obtained which was re d as equivalent to 0·000021 gramme. These results go to show that the method is quantitative within the limits of error of reading the mirrors.

Standard Mirrors.

The standard mirrors were prepared:—

(*a*) By precipitating with sulphuretted hydrogen in a dilute hydrochloric acid solution double the quantity of arsenious oxide that it was intended to "Marsh." Thus, to prepare a mirror equal to, say, 0·000015 gramme arsenious oxide, 0.00003 gramme would be precipitated in 70 c.c. of liquid, *i.e.*, in about the same volume of liquid as is used for the precipitation in an actual estimation of arsenic in fuel. The precipitate of arsenic trisulphide was then treated exactly as has been already described.

(*b*) By precipitating the arsenic with sulphuretted hydrogen in a solution containing not merely water and hydrochloric acid, but also an amount of calcium chloride equivalent to 3 grammes of lime.

It was found that those two sets of standards agree closely with one another.

GEORGE McGOWAN.
R. B. FLORIS.

Ealing, January, 1903.

* The expression "to steam" means in this instance to evaporate without boiling.

Appendix 24.

APPENDIX 24.

MR. HAMMOND SMITH'S REPORT ON FOODS, ETC.

REPORT BY MR. H. HAMMOND SMITH, M.R.C.S., TO THE ROYAL COMMISSION ON ARSENICAL POISONING ON INQUIRIES MADE BY HIM FOR THE COMMISSION AS TO THE LIABILITY OF ARTICLES OF FOOD AND DRINK (OTHER THAN BEER) TO BE CONTAMINATED BY ARSENIC.

Since my appointment by the Royal Commission last year my inquiries have been directed to the following points:—

(1) The use in the preparation of sundry articles of food and drink of substances liable to contain arsenic, or liable to introduce arsenic into the finished product.

(2) The precautions which have been and are now being taken by manufacturers and vendors of foods or drinks to avoid risk of arsenical contamination.

(3) I have further sought to obtain where possible an estimate of the degree of contamination of various foods or drinks by arsenic which might arise on the assumption that all precaution was neglected; and to collect any information available as to the quantities of arsenic which have been actually found to be present in samples of particular foods or drinks.

The selection of articles of food or drink for inquiry has been determined partly by suggestions made by witnesses to the Commission; partly also by the information which a large number of public analysts kindly put at the disposal of the Commission in response to the circular issued last autumn, and by information which has come to my knowledge in various other ways.

I wish to express my thanks to the large number of merchants and manufacturers whom I visited for the assistance which they gave me as a representative of the Commission. I received valuable help from Mr. Shirley Murphy, Medical Officer of Health of the London County Council, Dr. Wright Mason, Medical Officer of Health of Hull, Dr. Davies, Medical Officer of Health of Bristol, and many other officials in the Public Health service. I am also indebted to several public analysts and to chemical advisers to various works for information readily supplied at my request.

The Commission having arranged that special samples needing examination should be tested for arsenic by Dr. G. McGowan, I have on several occasions obtained his assistance, and in this report I record results of analyses which he has made of samples received from me.

It is convenient to deal with the subjects of inquiry under sections, as follows:—

[*In this report the term "food" is for brevity employed to cover articles of drink as well as of food. The term "arsenic" is used to denote arsenious oxide, not arsenium.*]

SECTION I.—Preliminary notes as to certain ingredients of foods, or substances used in the preparation of foods, which are liable to contain arsenic, and as to the quantities of arsenic which they may contain.

SECTION II.—Certain foods in which opportunities of arsenical contamination may arise by reason of the use in their preparation of the above ingredients or substances.

SECTION III.—Foods prepared by direct exposure to products of combustion of fuel liable to contain arsenic.

SECTION IV.—Miscellaneous: Flesh of fowls receiving arsenic; arsenical insecticides; arsenic in enamel of cooking utensils, etc.

SECTION V.—Summary.

SECTION I.

PRELIMINARY NOTES AS TO CERTAIN INGREDIENTS OF FOODS, OR SUBSTANCES USED IN THE PREPARATION OF FOODS, WHICH ARE LIABLE TO CONTAIN ARSENIC, AND AS TO THE QUANTITIES OF ARSENIC WHICH THEY MAY CONTAIN.

SULPHURIC ACID.

Acid prepared from pyrites.—The acid supplied by Messrs. Nicholson may be regarded as showing the highest proportion of arsenic at all likely to be met with in commercial oil of vitriol obtained from pyrites, and not de-arsenicated. Subjoined are maximum amounts of arsenious oxide in Nicholson's acid which have been reported to the Commission:—Professor Dixon's analyses, 1·45 arsenious oxide per cent., apart from precipitate; Professor Campbell Brown, 2·6 arsenious oxide per cent., or 1·9 per cent., apart from precipitate.

The quantities of arsenic in commercial sulphuric acid which has not been de-arsenicated, and has not come from Nicholson's, have, in some instances, been mentioned to the Commission. Mr. Morris, for example, (Qs. 4724 to 4729) reported from 0·1 per cent. to 1·6 per cent. of arsenious oxide in such acid. Evidence has been given that where pyrites acid is de-arsenicated arsenic can be, and is, eliminated to such an extent as to be negligible as a possible contamination of food substances directly or indirectly prepared by its means. It has been pointed out, however, by certain witnesses that there is risk through lack of uniformity in the process of de-arsenication applied during the manufacture of this acid, which goes on continuously day and night. Mr. G. E. Davis has especially insisted on this point (Q. 6381). I understand that no maximum limit of permissible arsenic in de-arsenicated pyrites acid has been adopted as a standard by sulphuric acid manufacturers. I have only visited one sulphuric acid manufacturer, Messrs. W. Berk and Co., of Stratford. At these works I was informed by the firm's chemist that de-arsenicated acid is tested by a Marsh test before being sent out, and is required to contain no more arsenic than ·0001 of a grain (*i.e.* 0·0064 milligramme) in 12½ cc. of the acid as sold.*

I may note that the tests for arsenic which are required by the British Pharmacopœia to be applied to B.P. sulphuric acid are not defined in such a way as to fix any proportion of arsenic which may be permitted to be present; the official requirement being that "no arsenium" should be detected by certain qualitative tests.

Acid prepared from spent oxide.—The Commission has had evidence regarding the freedom from arsenic or otherwise of sulphuric acid prepared from spent oxide. Witnesses who have detected arsenic in acid thus pre-

NOTE.—*Price of Sulphuric Acid*:—The price paid by the consumer to the acid maker for sulphuric acid "commercially free" from arsenic appears to be the same by whichever process the acid has been manufactured. For example I am informed that at present the average price paid for any such "arsenic free," concentrated oil of vitriol of S.g. 1·840 is £4 a ton.

* Mr. G. E. Davis, in 1903, kindly sent to the Commission two samples of oil of vitriol which in his view were, in a commercial sense, fairly representative (*a*) of acid before dearsenication, (*b*) of acid after thorough dearsenication. These were submitted to Dr. McGowan, who found (*a*) to contain 0·152 arsenic per cent., and (*b*) to be free from arsenic by the delicate test he employed.—H. H. S., July 1903.

pared in each instance have referred to its being present in "small quantities," or in "traces," no quantitative estimate being given (Morris 4812-14) (Davis 6381).

Acid prepared from recovered sulphur, in its relation to arsenic, has been referred to by Professor Dixon (3475), Mr. Davis (6483, 6507-8), as liable to possible slight contamination by arsenic, no quantitative estimate however being given.

The exclusive use of sulphuric acid prepared *from Sicilian brimstone*, in the preparation of articles of food has been advocated to the Commission by several witnesses. At Messrs. Berk's a plant for the manufacture of acid from Sicilian brimstone, at the date of my visit, had been recently set up in consequence of demands made by sugar manufacturers and others as a result of the "beer scare." Minute proportions of arsenic are occasionally met with in acid thus prepared, but no difficulty is experienced in producing, without the use of a de-arsenicating process, Sicilian brimstone acid which complies with the same limits that are adopted for de-arsenicated pyrites acid, viz., below ·0001 of a grain in 12½ cc. of acid as sold. Having ascertained from sugar manufacturers the danger which may arise from the accidental mixture of arsenical with non-arsenical acids, I may note that at Messrs. Berk's the plant for the manufacture of the two kinds of acid is kept distinct, and that the carboys containing pyrites acid are carefully kept apart from those containing brimstone acid. At these works, at the time of the "beer scare," several consignments of de-arsenicated pyrites acid were returned to the firm on account of the arsenic which they contained, but this has not since occurred. The brimstone acid is sold under guarantee of being "commercially free," and the firm exhibits the Marsh mirrors obtained therefrom to customers.

Acid prepared by the synthetic process.—In the manufacture of sulphuric acid in this way, it appears to be essential for the success of the process to take the greatest care to eliminate arsenic. I understand that the synthetic acid is being increasingly used in this country. I have not, however, met with any instance in which it was being employed by any manufacturer of foods or food ingredients.

Use of Sulphuric Acid for Food Purposes.

This acid is, of course, largely used in the manufacture of glucose and invert sugar. It also enters into the manufacture of hydrochloric acid, tartaric acid, and citric acid, and many other chemical substances used in the preparation of food.

With regard to the *direct addition of sulphuric acid to foods or drinks*, it appears to be certain that at one time sulphuric acid was by no means uncommon as an adulterant of gin and other cheap spirits. I have myself been informed by a retired publican from the East of London that some years ago this practice was general among publicans in the East End, and was adopted by himself. He said, indeed, that a certain class of customers would not purchase spirits unless they had been sophisticated with acid. A recent writer in the *Daily Express* (October 11th, 1900) on adulteration of spirits referred to the addition of acid as being practised at the present day, and gave recipes in which oil of vitriol is directed to be added to gin and rum, and nitric acid to whiskey.

Besides this newspaper article and statements made to me on second-hand information which I have been unable to investigate further, I have received no suggestion that sulphuric acid is commonly used to adulterate spirits at the present time. I can find no record of any recent prosecutions under the Sale of Food and Drugs Acts for this form of sophistication of spirits. In view, however, of the statement of the retired publican to whom I have alluded, it would seem possible that acid adulterated spirit would be sold only to particular customers, and it is probable that specimens of such spirits would not be easily obtainable by inspectors under the Sale of Food and Drugs Acts. The Public Health Department of the London County Council has lately had this point under consideration, in view of the possibility that alcoholic neuritis in spirit drinkers may be related to arsenic introduced into spirits by means of added acid, and the Council has suggested to certain of the London borough councils that it is desirable to obtain specimens of cheap spirits for analysis. This action was quite recently taken, and I have not yet learned what results have been obtained.*

I have heard of one instance in which a mineral water maker's chemist found free sulphuric acid in a sample of aërated water made by another firm, but I have met with no evidence that acidulation of aerated water by means of sulphuric acid is at all a general practice, and perhaps the presence of sulphuric acid in this particular sample may be referred to the plant for making carbonic acid gas, and not to intentional addition of acid. Appendix 24.

The addition of free sulphuric acid to vinegar, according to the information given me by several vinegar makers, although formerly the rule, is now seldom, if ever, practised. A small quantity of free sulphuric acid (1 ounce to 10 gallons) appears to be occasionally added to pickles (Report of Departmental Committee on Food Preservatives. Evidence of Mr. Boseley, 1056).

Sulphuric acid may also be used to give the brown colouring to ordinary brown sugar.

Hydrochloric Acid.

The liability of hydrochloric acid to contain notable quantities of arsenic in consequence of its preparation from sulphuric acid is, of course, well known. The largest quantity of arsenic in hydrochloric acid that has been mentioned to the Commission was 1·12 grammes per litre, in a sample recently examined by Mr. G. E. Davis (6466). The amount of arsenic in hydrochloric acid can, however, be reduced to very small limits by suitable processes of manufacture. It is evidently desirable that where hydrochloric acid is used in the manufacture of articles of food precautions should be taken to ensure the acid being satisfactory as regards arsenic.

As in the case of sulphuric acid, no maximum quantity of permissible arsenic in acid used for food purposes appears to be adopted by food manufacturers as a standard. As regards the hydrochloric acid of the British Pharmacopœia, the official tests for arsenic do not fix any maximum proportion which may be permitted to be present.

Use of Hydrochloric Acid for Food Purposes.

This acid is stated to be largely used in the manufacture of glucose in America, but I have not met with its use for the purpose in this country. It is, however, largely employed at sugar refineries for cleansing the charcoal of the filters. Similarly, it is employed for cleansing vessels of various kinds which are used for food purposes—bakers' tins and the like. Hydrochloric acid enters into the preparation of certain forms of meat extracts, and is used in the preparation of gelatine. It is also employed in the manufacture of a certain patent preparation of rice used by brewers, and occasionally as a substitute for tartaric acid in making puff pastry.

Phosphoric Acid.

The liability of phosphoric acid to contain arsenic appears to be generally recognised (cf. Thorpe's Dictionary of Chemistry, Vol. III., page 200). It will be remembered that Mr. G. E. Davis stated to the Commission that as long ago as 1876 he found a sample of phosphoric acid to contain as much as 2·6 grammes per litre (18·2 grains of arsenic per lb.).

At a large firm of sugar manufacturers, I was informed that arsenic was ordinarily detected in every sample of phosphoric acid examined. Commercial phosphoric acid containing no more arsenic than one part per million (1-140th of a grain per lb.) can, however, be obtained without much difficulty. In the spring of 1901 this firm rejected samples of phosphoric acid which contained more than three parts of arsenic per million (over 1-46th of a grain per lb.). Messrs. May and Baker, chemical manufacturers, informed me that phosphoric acid sent over from France and Germany as being free from arsenic, when tested by the Gutzeit method used at their works, has not infrequently been rejected as containing too much arsenic to be sold for food or drug purposes.

Use of Phosphoric Acid for Food Purposes.

The principal uses of phosphoric acid for food purposes are in the refining of sugar, and also as an ingredient of certain mineral waters. The phosphoric acid used at sugar makers, such as Messrs. Lyle's, was of the kind known as "commercial," the price of which is about 3d. a lb., and has to be distinguished from "chemical" acid, the price of which is from 1s. to 1s. 3d. a lb. The commercial acid is made from sul-

* Now *see* Appendix, No. 28.—H. H. S., July 1903.

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phuric acid and bone ash or natural phosphate, the proportion of acid used to the total phosphoric acid produced being (Mr. Voss) about 70lbs. sulphuric acid to 100 lbs. phosphoric acid.

With regard to "chemical" acid, which may be presumed to be the acid habitually used by druggists, I was informed by Mr. Voss and Mr. Tyrer that no risk of introduction of arsenic arose in the process of its preparation from phosphorus. Moreover, in order to remove any lead, the dilute acid before concentration is subjected to prolonged treatment by a stream of sulphuretted hydrogen which would remove arsenic if it were there. Messrs. May and Baker, who buy chemical phosphoric acid, inform me, however, that the foreign samples referred to above as being occasionally arsenical, are supplied to them as "chemical acid."

"Phospho-Citric" and "Liquid Tartaric" Acids.

A commercial substance called phospho-citric acid is largely used in the preparation of temperance drinks as a substitute for citric or tartaric acid. I am informed by chemical manufacturers that it consists of a mixture of commercial phosphoric acid, about 85 per cent., and citric acid, about 15 per cent. Commercial phosphoric acid is also sold to temperance drink manufacturers under the name of "liquid tartaric acid." Dr. Niven in his evidence before the Commission (535) stated as regards a particular firm which manufactures phosphoric acid for mineral water makers that he knew the origin of the acid and the bone ash from which the phosphoric acid is prepared, and that he did not think there would be any arsenic present.

PHOSPHATES.

The liability of phosphates of various bases to contain arsenic is also generally recognised.

I understand from Mr. Tyrer that certain chemical manufacturers prepare phosphates (for example, phosphate of soda) with phosphoric acid obtained by the combustion of phosphorus, and that in this instance the phosphate would be practically free from arsenic.

On the other hand, cheaper varieties of phosphates are not so prepared; the acid phosphates used in baking powder and the like are more usually obtained from bone ash or natural phosphate during the process of making superphosphate of lime, and, in consequence, are liable to contain arsenic. Mr. Tyrer stated that before the 1900 epidemic no particular care, as far as he was aware, was taken in the selection of the sulphuric acid employed to manufacture acid phosphates for making baking powders or for other food purposes. One large firm of wholesale chemists whom I visited had, at the time of the Manchester epidemic, tested a large stock of phosphate of soda, and returned it to the agents who supplied it in consequence of the arsenic it contained; in ordinary circumstances, this phosphate of soda would have been supplied to druggists or to food manufacturers. Another firm, who manufacture for druggists, informed me that they not infrequently reject samples of phosphate of soda for the same reason.

Large quantities of arsenic were reported early in 1900 in certain samples of phosphate of soda; some of these are given by analysts who have made returns to the Commission as follows:—

Professor Campbell Brown:

One sample rock phosphate, a trace of arsenic.

Mr. W. W. Fisher:

Phosphate of soda containing arsenic equal to ·0724 per cent., or 5 grains to 1 lb.

Mr. W. F. Lowe:

Four samples of phosphate of soda, containing respectively 4·06, 1·96, 1·96, and 0·7 grains of arsenic per lb.

Mr. L. Reed:

Two samples of phosphate of soda containing ·02 per cent. of arsenium.

Mr. F. W. Stoddart:

Three samples effervescing phosphate of soda containing respectively a trace of arsenic, 8¼ grs. per lb., and 3½ grs. per lb.

Mr. T. H. Walker:

Three samples of phosphate of soda containing 1 part of arsenic in 200,000 to 1 part in 100,000.

I gather that the more grossly contaminated of these samples examined in 1900 probably came from one source, where the presence of arsenic was due to the accidental admixture of sodium arsenate with sodium phosphate. Attention having been directed, however, by this occurrence to arsenical contamination of phosphates in general, it was found that a large proportion of phosphates on the market also contained arsenic in varying degrees. I have no knowledge of the origin of the several arsenical samples referred to in the above list, but it is probable that the smaller proportions referred to were in samples not connected with the accident mentioned. Mr. Lowe informs me that the sample of sodium phosphate in which he found 0·7 of a grain per lb. was of this nature. It is right to add that Mr. Stevenson, who purchases phosphates on a large scale, informed me that recently phosphates have been much more satisfactory as regards arsenic than formerly.

The principal *use of phosphates for food purposes*, as has been indicated, is in the manufacture of baking powders, self-raising flour, and the like.

TARTARIC ACID.

That this acid is likely to be contaminated with arsenic has been stated to the Commission by Mr. Davis and Mr. Lawrence Briant. A similar statement has been made by Dr. Campbell Brown in his Analysts Return. In the British Pharmacopœia the liability of tartaric acid to arsenical contamination is also mentioned. In the British Pharmacopœia it is laid down that tartaric acid should yield no reaction with the pharmacopœial qualitative tests for arsenium. To what extent a minute quantity of arsenic in a gramme of substance might escape notice by these qualitative tests, I am unable to say. I have not any reference to the quantity of arsenic found in tartaric acid, except in the evidence given before the Commission by Mr. Lawrence Briant, who found 1-30th and 1-50th of a grain of arsenic per lb.

An important manufacturer of tartaric and citric acids informed me that notable quantities of arsenic have been found in foreign makes of tartaric acid; he, however, did not state any specific proportion of arsenic which had been determined.

As to the source of arsenic, the following information obtained from Messrs. Bennet, Lawes and Co., may be noted. In the manufacture of this substance from wine lees, hydrochloric acid is used in the first part of the process, which consists in decomposing the acid potassium tartrate in the lees, and recovering the tartaric acid as calcium tartrate. The latter is treated with sulphuric acid, forming sulphate of lime and tartaric acid. The solution of tartaric acid is purified by sulphuretted hydrogen, the principal object of which is to precipitate lead derived from the pans. The tartaric acid obtained after sulphuretted hydrogen treatment may be dried and powdered; or, if a pure crystallised article is needed it is redissolved and recrystallised, being subjected to additional sulphuretted hydrogen treatment.

A great difficulty in making tartaric acid is to insure its freedom from lead. At Messrs. Bennet, Lawes' works, the test employed to ensure sufficient removal of lead is to pass through a sample of the liquor from which the tartaric acid is to be crystallised, sulphuretted hydrogen five times as strong as that employed in the process. Such a test, it is claimed, would equally exclude any arsenic, which at these works would be detected if as much as ·0002 per cent. were present. The test is applied by the chemist at the works. The sulphuric acid used at these works is guaranteed to be made from Sicilian brimstone or from spent oxide, and, together with the hydrochloric acid, is tested by sulphuretted hydrogen before use. At these works it is the custom to preserve for reference a number of small samples of the finished article from day to day. The presence of arsenic in considerable amount in tartaric acid, if this in fact occurs, would seem readily accounted for by neglect of such precautions as those just indicated. And that the quantity of arsenic that could be introduced under these circumstances might be considerable may be judged from the fact that, as Mr. Bennet informed me, the quantity of sulphuric acid used to produce 1 cwt. of tartaric acid at his works, is 190 lbs., and that, in the opinion of his chemist, the mere process of crystallisation, without sulphuretted hydrogen treatment, could not be depended on to remove arsenic introduced by contaminated acid.

Use of Tartaric Acid in Food.

This acid is largely used as an ingredient of various temperance drinks, lemonade powders, effervescing powders, sherbet, and the like. It is also employed to invert sugar in the manufacture of sweets, and it is an important ingredient of baking powders.

CITRIC ACID.

The liability of citric acid to contamination by arsenic has been frequently referred to by witnesses; like tartaric acid, it arises from the use in its manufacture of sulphuric acid. I have not, however, met with any statements as to the quantity of arsenic determined in particular samples. In the British Pharmacopœia, arsenic is not mentioned as being a contamination which should be looked for in citric acid. At Messrs. Bennet, Lawes and Co., citric acid is made by the action of sulphuric acid on citrate of lime in much the same way as tartaric acid from calcium tartrate, the same precautions as to selection of acid and treatment by sulphuretted hydrogen being followed. The sulphuretted hydrogen in this case is passed through the solution out of which the citric acid is to be crystallised two or more times before crystallisation, till the solution gives no "reaction for lead." The test employed is the same as in the case of tartaric acid, and similarly it is claimed that it ensures freedom from more than ·0002 per cent. of arsenic.

In estimating the liability of citric acid to contain arsenic, in the absence of suitable precautions, it may be useful to note that at Messrs. Bennet and Lawes' works about 135lbs. of sulphuric acid are used to produce 100lbs. of citric acid.

Use of Citric Acid in Food.

Citric acid is an ingredient of various temperance drinks, flavouring syrups, artificial lemonade, lemon crystals, etc.

SULPHUROUS ACID; SULPHITES AND BISULPHITES; ACETIC ACID.

The liability of these substances to contain arsenic has been mentioned to the Commission (sulphites, Briant, 7232; acetic acid, Davis, 6453), but no instances in which notable quantities of arsenic have been detected in them have been mentioned either by witnesses or by public analysts in their returns.

It is perhaps hardly necessary here to deal with them in detail, as the degree of such liability appears slight, and as the proportions of these chemical substances which enter into foods is relatively small. As regards *sulphurous acid and sulphites*, I ascertained from one firm manufacturing it that the sulphur dioxide is passed through washing bottles. The firm claimed that this would prevent arsenic, if any, which might accidentally come over, from contaminating the finished product. Mr. Briant in his evidence (7233) informed the Commission that washing the gas is universally practised, and affords a sufficient safeguard against arsenic.

Sulphurous acid is used at sugar refineries; sulphites and bisulphites are largely used as preservatives in "British wines," beer, and temperance drinks, lemon juice, etc.

As regards *acetic acid*, it may be possible that in its preparation by the action of sulphuric acid on acetate of soda or lime, some arsenic, if present in the sulphuric acid, would come over with the distillate, although the temperature of distillation is below the volatilising point of arsenious oxide. But I understand it is usual to conduct the distillation in silver coils. The chemist of Messrs. Beaufoys (who manufacture acetic acid on a large scale) stated that it is essential to the process to take strict precautions as regards the purity of the sulphuric acid employed, and that such precautions include securing freedom of the acid from arsenic, which if present would lead to corrosion of the silver.

Acetic acid is used in the preparation of certain cheap vinegars, especially foreign, and also in the manufacture of pickles.

BORAX AND BORIC ACID.

From evidence given before the Commission, it appears that borax and boric acid have frequently been found contaminated with arsenic. Dr. Stevenson in his evidence (Q. 2358) stated that no sample of boric acid or borax examined by him was free from arsenic; the largest amount he found in borax was 0·35 of a grain per lb. (·005 per cent.). In his return to the Commission as Public Analyst, he has also stated that he examined 19 samples of borax, containing from ·0003 to ·003 per cent., equivalent to from 1-50th to 1-5th of a grain per lb. Mr. Dyer, Public Analyst for Leicestershire, states that in seven samples of borax he found from 1-100th to 1-6th of a grain per lb. Appendix 24.

The liability of borax to contain arsenic is recognised in the British Pharmacopœia, a qualitative test being prescribed for the pharmacopœial article. The British Pharmacopœia does not mention arsenic as a contamination to be looked for in the case of boric acid.

As regards the probable source of the arsenic, Mr. Locke, Secretary and Managing Director of the Borax Consolidated Company, informs me that in his experience arsenic in small amounts is almost always present in borax. He attributed its presence to the fact that the borate of lime, from which borax is chiefly made, occurs in volcanic regions, and said that he thought the frequent presence of sulphur in natural borates, which no doubt is due to the washings of volcanic debris, gave a clue to the probable origin of the arsenic. Mr. Locke said that it was possible to eliminate arsenic from borax by repeated recrystallisation, but that it was a very costly procedure, and, as a matter of fact, the borax in general use, for food and other purposes, is not so treated. Much of the borax which is termed "commercially pure" contained, he thought, on an average, from 1 part of arsenic in 30,000 to 1 part in 50,000 (about ½ to 1-7th of a grain of arsenic per lb. of borax). Chemically pure borax, which would be demanded for drug purposes, costs about £3 a ton more than the commercially pure article.*

Borax is now usually made by boiling the natural borate of lime with carbonate of soda. Boric acid is made from the same crude borate of lime by the action of sulphuric acid, the boric acid being left in solution, and then crystallised. The amount of sulphuric acid used in the process varies according to the amount of lime in the crude article. As a rule, about 1 ton of sulphuric acid is required to produce 1 ton of boric acid, but occasionally more is needed, as much as 2,700 lbs. per ton being sometimes employed. In the event of insufficient care being taken in the selection of the sulphuric acid, there would seem to be liability of considerable additional contamination from arsenic arising in this way. The sulphuric acid used at the various works of this company is, I was assured, carefully tested for arsenic before use. Like borax, boric acid can be freed from arsenic by repeated crystallisation. This would increase the price by from £5 to £9 a ton, constituting "chemically pure" boric acid, which would be demanded for druggists' purposes. The boric acid in general use for food purposes, however, is not the "chemically pure" acid. Mr. Locke informed me that the commercial acid contains on the average somewhere about 1 in 75,000 to 1 in 100,000 (1-11th to 1-14th of a grain of arsenic per lb.).

Use of Borax and Boric Acid in Food.—Borax and boric acid are largely used in preserving meat (especially hams and bacon) and other food products, particularly milk and butter.

GLYCERINE.

The liability of glycerine to contain arsenic appears to be generally recognised, and is referred to by several public analysts who have made returns to the Commission. Arsenious oxide is stated to be readily soluble in glycerine, forming a compound $C_3H_5AsO_3$, tritenyl arsenite (Allen's Commercial Organic Analysis, Vol. II., Part I., page 305). In the case of glycerine prepared from soapmakers' lyes, the principal source of the arsenic is the hydrochloric acid used to treat the crude glycerine first obtained. In the case of glycerine prepared by hydrolysis, the use of sulphuric acid appears to give an opportunity of arsenical contamination.

From data kindly supplied by Mr. Moore, of Liverpool, who has considerable experience of analysing glycerine, this substance when prepared by hydrolysis is seldom found to contain notable amounts of arsenic, whereas the commercial glycerine from soapmakers' lyes habitually contains arsenic.† The latter, however, for food and domestic purposes undergoes a

* The price of borax and boric acid fluctuates: the following are said to be current prices of the commercially pure articles per ton:—Borax (crystals), £13; (powder), £14. Boric acid (crystals), £22; (powder), £24.

† The temperature of distillation of glycerine is high (200° C.) and arsenic is volatilised when glycerine is distilled.

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process of de-arsenication which, if thoroughly applied, can produce an article as free from arsenical contamination as hydrolytic glycerine. De-arsenicated glycerine costs about £10 a ton more than glycerine not so treated.* Mr. Moore stated, however, that the degree of de-arsenication effected varied greatly at the works of various glycerine distillers.

The Gutzeit test of the British Pharmacopœia, 1898, constitutes the only official limit of arsenic in glycerine for domestic or drug purposes, and it is considered by no means stringent. Mr. Marshall, Public Analyst of Rochdale, has recently met with samples of glycerine containing 1-50th grain arsenious oxide per lb., which gave no indication by this Pharmacopœial test; Dr. Campbell Brown gives an instance of a recent sample estimated to contain between 9 and 11 parts arsenious oxide per million (up to about 1-13th grain per lb.), which passed the Pharmacopœial test; moreover, he has added to glycerine amounts of arsenic up to 1-60th grain per lb., without obtaining any reaction by the test. Mr. Moore has occasionally met with larger amounts of arsenic than the above in glycerine sold for food or domestic purposes, the highest quantity recently found being 1-7th grain per lb.

Some few years ago a considerable number of instances were recorded where the amounts of arsenic found in glycerine were conspicuously high. I have appended to this report a letter on this subject which Dr. Campbell Brown has kindly written, and which gives a number of useful references. Among quantities therein mentioned I note samples, referred to in "Pharmaceutical Journal," 1889, p. 205, in which the amounts of arsenic determined were from 1 in 6,000 (about 1 and 1-6th grain per lb.) to 1 in 2,500 (about 3 grains per lb.). In 1899 also, samples both English and foreign, intended for pharmaceutical purposes, were tested by Siebold. The majority contained from 1 part in 4,000 to 1 part in 6,000. Dr. Brown also gives references to several other instances in which large quantities of arsenic have been found by other observers. Mr. Fairley, of Leeds, examined in 1894 samples of glycerine taken in Leeds, with the following results: one contained 4 grains of arsenic per lb., another 2 grains, two others contained 1·75 grains, while seven contained traces.

I understand from Mr. Moore that, although the number of soapmakers in this country is large, they do not as a rule manufacture glycerine for sale, but sell crude glycerine to glycerine distillers, of whom there are about a dozen in this country. In his belief it is now rare for any of these firms to issue an article for food or domestic use which transgresses the Gutzeit test of the British Pharmacopœia, and the majority have far less arsenic in such glycerine than the above test would allow. He pointed out, however, that glycerine for domestic use is frequently imported. Some varieties of foreign glycerine are manufactured by well-known firms, but others come on the market merely as "glycerine," with no label or other indication of their origin. In certain of the latter he had found arsenic, but could not recall the proportion.

Use of Glycerine for Food Purposes.

The principal use of glycerine for food purposes which I have met with is as an ingredient of cakes and in the manufacture of certain forms of sweets. It is used in certain temperance drinks and in making meat extracts, also as an addition to wines.† It is, of course, given as a drug, the maximum pharmacopœial dose being 2 drachms. It is not infrequently taken, however, in larger doses than this.

Mineral Substances used for Colouring.

The liability of oxide of iron to contain arsenic has been mentioned to the Commission by Mr. Hehner (7931-7953), who pointed out that this oxide used as a colouring matter for food might contain 1-10th grain or more of arsenic per lb. I gather from his evidence that the pigment to which he referred was derived from the residue obtained in the manufacture of fuming oil of vitriol by the distillation of sulphate of iron. He has also stated that arsenic may be found in pigments composed of oxide of manganese (10210).

A sample of a mineral pigment, "Bole Armenia" (which in the belief of the manager was a natural earth), obtained last year at one of the London "Stores," was found by Dr. McGowan to contain over 4·5th grain of arsenic per lb. I have no reason to believe that the amount of arsenic in this sample is exceptional, and it is possible that at times it may be exceeded. Bole Armenia, I learn from a colour maker, consists of oxide of iron mixed with whitening.

Bole Armenia, oxide of iron, and other mineral pigments, are extensively used in colouring sausages, anchovy sauce, etc.

"Coal Tar" Colouring Matters.

The liability of certain pigments known generally as "aniline dyes" to contain arsenic, has occasionally been mentioned to me in the course of my inquiries. I gather, however, that so far as such liability arises from the use of arsenious acid in the actual preparation of the dye, at the present day it is practically confined to magenta pigments, and that much magenta is made without the use of arsenic. According to Mr. Allen (Vol. III., Part 1, p. 283) and others, arsenic has been found present in commercial magenta in considerable proportions, and at one time as much as 6½ per cent. was met with.

It is possible that the use of large quantities of sulphuric acid in the manufacture of coal tar colours or other processes by which they are prepared may occasion risk of introducing arsenic, and, in point of fact, I understand from Mr. Hehner and from Mr. Goodfellow (consulting chemist to the Confectioners' Union) that arsenic is frequently found in many.‡ As to the origin of the arsenic, however, I have made few inquiries, in view of the minute amounts of these pigments necessary to give the required colour to a large amount of the finished product. There are two references in the Report of the Departmental Committee on Food Preservatives, etc., to arsenic having been looked for and detected in colouring matters used in food, namely, in a colouring varnish used for smearing hams in Gothenburg (Report, p. 273), and in a chemical preparation for food called Kolichayam, used in Ceylon (Report, p. 278).

Glucose.

Having regard to the considerable evidence which has been given to the Commission respecting the manufacture of glucose, and its liability to become contaminated by arsenic in the absence of suitable precautions, it will suffice if I here summarise certain points which have already been before the Commission, and add a few further notes.

Quantity of Sulphuric Acid used in the preparation of Glucose in this country.—At Messrs. Bostock's (Tattersall), 6 per cent.; at the Manbré Co.'s (Q. 7355), less than 2 per cent.; at Garton Hill and Co.'s (Q. 6059), 4½ to 8 per cent., average 5 per cent. In general (Salamon, Q. 1466), 6 per cent. In general (Delépine, Q. 5239), 4 to 6 per cent.

The above are "solid" glucoses manufactured in this country almost solely for brewing purposes.

The quantity of sulphuric acid used in preparing *German solid glucose* for brewing purposes is stated by Mr. Wahl to be "considerably less than 2 per cent." (Q. 7432). This smaller percentage, he informed the Commission, was attributable to the purity of the potato starch employed, and to the consistency of the liquid treated.

With regard to the manufacture of *American solid glucose* used for brewing purposes, little evidence has been received by the Commission. From information given me by Mr. Heron, and in a letter from Mr. Mahana of the Glucose Sugar Refining Co., Chicago, which Mr. Heron has forwarded, it is claimed that sulphuric acid is now seldom employed, hydrochloric acid having been substituted for several years in American glucose factories. If this is so, it might be expected that such glucose would show on analysis a higher proportion of chloride than the glucose prepared by sulphuric acid. I have no information, however, to show whether or not this is the case, nor have I been able to obtain information as to the proportions of the hydrochloric acid employed for the purpose.

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* The price of unpurified glycerine varies, and is, of course, related to its specific gravity. I am informed that £50 a ton is a usual figure.

† The addition of glycerine to wines is prohibited in France and Denmark.

‡ Compare Appendix No. 27 and Dr. McGowan's Appendix No. 25, which give results of analyses of colouring matters made since this report was written.—H. H. S., July 1903

Amounts of arsenic found in solid glucose.—The following data reported to the Commission may here be noted:—

In Bostock's Glucose:—

	$As_4 O_6$.	
	Per cent.	Grains per lb.
Government Laboratory - -	·013 to ·047	0·89 to 3·28
Mr. Gordon Salamon - - -	·04 to ·07	2·8 to 4·9
Professor Delépine - - -	·015 to ·095	1·05 to 6·6
Mr. E. W. T. Jones - - -	·023	1·6
Professor Campbell Brown -	·008 to ·131	0·56 to 9·17

In Glucose other than Bostock's:—

	$As_4 O_6$.	
	Per cent.	Grs. per lb.
Government Laboratory: Sample from Paisley Sugar Co., November 1901.	·0013	·09
Professor Campbell Brown: 1 Sample not from Bostock's -	·004	·28
2 Samples not from Bostock's -	·0025	·175
Mr. Estcourt: 1 Sample of German Glucose -	·0014	·1
Professor Delépine: 1 Sample not from Bostock's -	·00007	·005
1 Sample not from Bostock's -	·0001	·007

Traces of arsenic in glucose other than Bostock's (quantities not specified) have been reported to the Commission by Mr. Miller (5341), Mr. Stein (5178), and by Dr. Stevenson (2480) in the case of old glucose of foreign origin.

Observations by Clouet and Ritter as to arsenic in glucose in 1876 or earlier have also been reported to the Commission. Prof. Delépine (table 12) quoted Ritter as finding from ·0013 per cent., or ·09 of a grain per lb. of arsenic to ·014 per cent., or about 1 grain per lb., in German glucose.

Precautions against arsenic at glucose factories.

The precautions (as regards the quality of acid used, and the testing of the finished product for arsenic) which were taken at British and German glucose fastories before the epidemic of 1900, and those which have since been taken, have been stated by many witnesses to the Commission. References: Salamon (1435—1457), Francis (7347—7352), Garton (6122) (6126—33), Wahl (7470) (7473) (7476), Stein (5186).

As regards American glucose, Mr. Mahana states without specifying details that stringent precautions against arsenic in the hydrochloric acid used are taken in the factories controlled by the Glucose Sugar Refining Co.

Arsenic in liquid glucose.—The solid glucose referred to is seldom used for food purposes other than brewing. For these other purposes the glucose used is in the form of syrup, termed "liquid glucose." The syrup is not manufactured in this country, but comes almost entirely from America, and what is not American comes from Germany. The liability of liquid glucose to contain arsenic, however, and the precautions taken and necessary to guard against that risk are substantially the same as with the solid product used for brewing.

Mr. J. Heron lately found arsenic in samples of American liquid glucose. In June, 1902, he found as much as 1·25th grain of arsenic per lb. in one sample, and condemned its use. He attributes the presence of the arsenic to the use of soda ash in neutralising. On his suggestion, the ash used at the American works was analysed, and was found arsenical.

Mr. Ling, in his evidence (Q. 10,576) stated he had found quite recently, in 1902, 1-12th grain per lb. in a foreign glucose, either American or German, he could not say which.

Use of Glucose in Food Materials other than Beer.

Liquid glucose is used, in greater or less proportion, in the preparation of the following, among other, articles of food:—

Sweetmeats, jams, marmalade, table syrup, liquorice, fruit syrups, temperance drinks, some clarets and British wines, biscuits, gingerbread, vinegar.

Guarantees.

It will be convenient here to note the nature of the demands which I ascertained were being made by certain English firms manufacturing some of the above substances. The larger number, in consequence of the "beer scare," took steps to ascertain by analysis (about the end of 1900) that the glucose which they were then using was free from arsenic. Since then they have been content to require from the glucose merchant or middlemen a guarantee in general terms that glucose supplied is, or will be, free from contamination. This may be done in various ways: for example, it may be stipulated in a contract, or by a written assurance, or (most commonly) the food manufacturer accepts an invoice with a statement (printed or stamped on it) that the glucose is free from arsenic.

In my previous evidence (Q. 8794), I referred to the somewhat loose manner in which such guarantees are given by merchants and middlemen. The chief glucose merchant I visited informed me he does not have the glucose analysed, but sells on a guarantee from manufacturers. He finds the buyers do not require a guarantee with each parcel or consignment of glucose, but are content with a general guarantee.

One firm of confectioners whom I visited, however, now require a specific guarantee relating to each consignment delivered. Certain other firms (since the "beer scare") have from time to time caused samples to be analysed, and in three instances I found that such analyses were being made frequently and systematically. I have heard of no instance in which any glucose was tested for arsenic by a food manufacturer before the epidemic of 1900.

I may here record my impression, derived from recent discussion with various users of glucose, that their present tendency is rather in the direction of relaxing than of strengthening the checks on the guarantees of the glucose vendors, which can be secured by analysis made by their own chemists. At one large confectionery works I was informed by the secretary that since he had been there, namely, for six months, glucose had not been analysed, and that he had no knowledge of its being analysed before he went there. At these works the glucose is bought under a guarantee, but only of quality, not of freedom from arsenic.

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The following summary of precautions taken to ensure freedom from arsenic since the Manchester epidemic at certain large firms visited, other than brewers using glucose, may be useful:—

Firm visited.	Glucose bought under Guarantee of Freedom from Arsenic by Vendor.	Tests applied for Arsenic since 1900 by Firms purchasing Glucose.
A. Confectioners, London	Yes	Every consignment tested by their own chemist, and occasionally tested by an independent chemist.
B. Confectioners, Bristol	Yes, but rely on analysis	Every consignment tested by their own chemist.
C. Confectioners, London	At date of first visit, no. At subsequent visits, yes.	At first occasional tests by outside chemists. Now the firm have engaged an analyst at their own works.
D. Mineral Water Makers	Yes	Tested by their own chemist.
E. Chocolate Makers, Bristol	Yes, subject to analysis	Occasionally tested by public analyst.
F. Confectioners, London	Yes	Once tested by Dr. Dupré.
G. Provision Manufacturers	Yes	Once tested.
H. Cake and Biscuit Makers, Reading	Yes	Occasionally by the public analyst.
I. Cake and Biscuit Makers, Bristol	Yes	Once tested.
J. Vinegar Maker, Bristol	Yes	Never tested.
K. British Wine Manufacturer, London	Yes	Never tested.
L. Jelly Makers, Maidstone	Yes	Never tested.
M. Confectioners and Makers of Golden Syrup, London.	No	None.

With regard to three wholesale merchants selling Glucose, the following may also be noted—

Firm.	Guarantee of freedom from Arsenic.	Tests applied.
N., London	Gives to purchaser a guarantee with each consignment, or a general guarantee, as may be demanded.	Has had glucose tested, but does not test each consignment sold, or even a sample of each consignment bought.
O., London	ditto ditto	Do not test. Rely upon a guarantee given by the foreign manufacturer.
P., London	ditto ditto	Do not test.

Invert Sugar.

The invert sugar, about which the Commission have received evidence on many occasions, is an important ingredient of beer. I have not learnt, however, that invert sugar, as such, is sold to manufacturers of articles of food and drink other than beer, with the exception of cider and certain fermented temperance drinks. The liability of the brewers' invert sugar to be contaminated by the use of arsenical sulphuric acid has been fully before the Commission. The quantity of arsenic reported in Bostock invert sugar (in the preparation of which about 3 per cent. of sulphuric acid was employed) varied as follows:—

	$As_4 O_6$	
	Per cent.	Grains per lb.
Professor Delépine	·02	1·4
Professor Campbell Brown	·062	4·3
Government Laboratory	·024 to ·046	1·67 to 3·21

As will be seen below, certain golden syrups and articles of confectionery mainly consist of cane or beet sugar, inverted by mineral acids or otherwise. But in their manufacture invert sugar is not bought as such, but is produced in the process of the manufacture of the finished product.

Caramel.

The liability of caramel to contain arsenic has been illustrated by the evidence which the Commission have received (Miller, Q. 3325 to 3336), Briant (Q. 7268 to 7287). Mr. Miller informed the Commission that a sample of caramel not coming from Bostock's had been found to contain "about as much arsenic as Bostock's invert sugar." Mr. Briant had not found more than 1-100th of a grain per lb. The arsenical caramel in both cases was stated to have been of foreign manufacture. 1-40th grain of arsenic per lb. in a sample of caramel intended to be used for colouring black beer is referred to in the Government Laboratory Report for the year ending March, 1902.

The Commission have had evidence from Mr. Briant (Q. 7268, Q. 7286) as to the manufacture of caramel, and it would seem that many caramels are made from glucose either by heat alone or with the addition of alkali. Other caramels are prepared from cane or beet sugar.

Mr. Heron informed me that both caustic soda and caustic potash are used in the preparation of caramel, and that the danger of arsenical contamination mainly arises from the use of these substances.

Use of Caramel for Food Purposes.

Caramel is largely used as a colouring matter in many kinds of food, for example, vinegar, temperance drinks, cider, confectionery, and in cooking. Certain manufacturers make a practice of requiring an assurance that all caramel applied to them should be made from cane sugar.

Since the Manchester epidemic demand has been made by some manufacturers for a guarantee that the caramel supplied to them should be free from arsenic, and in a few instances this has been checked by analysis. Such guarantee, however, is often neither asked for nor offered by the vendors.

I think that, as a rule, manufacturers are less aware of the liability of caramel to contain arsenic than in the case of glucose.

Raw (Unrefined) Sugar.

The fact that raw sugar may contain small quantities of arsenic has been mentioned to me by sugar refiners; the same fact has been referred to by Mr. Hehner (Q. 10,209) in his evidence to the Commission on June 13th, 1902, when he stated that he had met with 1-100th of a grain of arsenic per lb. of beet sugar.

On visiting one firm of sugar refiners in July, 1902, I found that this subject had engaged the attention of their chemists for many months. Raw sugars, cane or beet, coming from various countries, had been frequently tested; sometimes 20 grammes of sugar (the quantity recommended by the Arsenic Committee of the Societies of Public Analysts and Chemical Industry) being employed in the Marsh-Berzelius test, sometimes considerably larger quantities. The result, broadly speaking, had been that traces of arsenic were found in many raw sugars of different kinds, and from different countries, the largest amount detected being about 1-140th of a grain of arsenic per lb. of raw sugar.

The presence of arsenic in raw (cane or beet) sugar appears capable of being accounted for by the use of lime in its preparation. In the first treatment of beet or cane juice to remove impurities, etc., lime is added to the juice. The lime is then precipitated by passing carbonic acid gas through the liquor. Both lime and carbonic acid are usually derived from a special kind of lime kiln, in which the carbonate of lime is burnt with coke. There is thus opportunity of arsenic volatilised from the coke reaching the sugar liquor, as well as opportunity of arsenic from the coke reaching the lime used in the process. Appendix 24.

Moreover, if, after the bulk of the sugar has been extracted, the residual molasses are treated to obtain a further quantity of sugar, the processes usually employed (lime, baryta, or strontium processes) consist in adding a much larger proportion of lime or other base than was used in the case of the beet juice, with the object of making a basic "sucrate," which afterwards is generally decomposed by carbonic acid gas. In these processes, therefore, the opportunities of contamination by arsenic derived from the base or from the carbonic acid gas would seem to be increased.

I inquired as to two processes of recovering sugar from molasses which are mentioned in Thorpe's "Dictionary of Chemistry": the alum process, and "Margueritte's process," in which sulphuric acid is added to the molasses to convert all bases present into sulphates. Neither of these processes now appears to be in practical use.

Malt.

Having regard to the amount of evidence given before the Commission as to the liability of malt to be contaminated with arsenic, in relation to beer, it is only necessary for me to refer here to malt, for the value of completeness, as in addition to its use in beer it is used as an ingredient in malt extracts and sundry malt foods.

Appendix 25. SECTION II.

AS TO CERTAIN SPECIAL FOOD SUBSTANCES, WHICH BY REASON OF THEIR MANUFACTURE WITH THE ABOVE INGREDIENTS APPEAR SUBJECT TO RISK OF ARSENICAL CONTAMINATION.

TREACLE, GOLDEN SYRUP, AND TABLE SYRUPS.

Syrups of this class may roughly be divided into—

(a) Those in which the principal constituent is cane or beet sugar inverted in greater or less degree in order to prevent crystallisation.

(b) Those in which the principal constituent is liquid glucose.

With regard to (a), I subjoin a few notes of a visit to Messrs. Lyle, who manufacture golden syrup on a very large scale. A syrup is made at the works from raw cane or beet sugar. From this syrup, in the process of sugar refining, a single crop of sugar crystals is obtained; the remainder of the syrup is utilised to make golden syrup. It was the firm's custom at one time to completely invert, by means of sulphuric acid, one-half of the bulk of this cane sugar syrup, and to add to that the other half which had not been so treated, but this process has now been discontinued, the plan at present adopted being to "partially invert" the whole bulk of the syrup employed. This is done by sulphuric acid, of which from ½ to 2 per cent. is used. The acid is neutralised by carbonate of lime, and the syrup is filtered through animal charcoal, and subsequently concentrated in vacuum pans to the density required.

At Messrs. Fowler and Co., who manufacture treacle on a large scale, the raw material used is imported molasses. These molasses are also subjected to a "partial inversion," by means of sulphuric acid, followed by neutralisation and filtration through charcoal. Two per cent. of anhydrous sulphuric acid is used. At these works no phosphoric acid is employed. Neither Messrs. Lyle nor Messrs. Fowler add glucose to their product. It should be noted that hydrochloric acid is employed at these works, and at sugar refineries generally, to cleanse the charcoal filters; also that a small amount of phosphoric acid may be added to the preparation of syrups of this kind.

The degree of risk from arsenic which syrups of this class would entail in the absence of efficient precaution, is evidently of the same high order as that presented by brewers' invert sugar (Section I.), and it deserves to be remembered in this connection that these are food substances which people consume in considerable quantities.

Below are notes regarding the precautions against arsenic in sulphuric, phosphoric, and hydrochloric acids taken at the dates of my visits at the works of the two firms above mentioned.

Purchase under guarantee.—At both these works it is stipulated that the sulphuric acid purchased should be made from Sicilian brimstone.

This is at both works a precaution taken in consequence of the Manchester epidemic, and in addition to those furnished by the system of testing for arsenic to which I am about to refer.

Phosphoric acid used at Messrs. Lyle's was "commercial acid," and was being guaranteed free from arsenic.

Tests for arsenic.—At Messrs. Fowler's, samples of sulphuric acid are collected from every carboy of a consignment. An aggregate sample is made up from every four samples thus taken; these are tested by a Marsh-Berzelius method, which is said to detect one part arsenic per million, the analysis being made by the works chemist. If arsenic is found in an aggregate sample, each of the four constituent carboys is separately analysed. Records of all analyses are kept.

This plan of systematically testing sulphuric acid for arsenic has been easy to adopt as a similar method of sampling has been practised for many years as a check on the strength of the acid. Before the 1900 epidemic, however, it had been the custom at these works to occasionally test the sulphuric acid for arsenic. Last year one consignment of sulphuric acid was rejected as the result of the system of testing now employed.

At Messrs. Lyle's, a bulk sample representing every carboy is tested by the works chemist; if any arsenic is found each carboy is separately tested. The test employed is a Marsh-Berzelius. Records are kept of all analyses; these records are kept under the following heads, both positive and negative results being recorded: "Date of purchase; No. of carboys; Sp. gr.; Temp.; Arsenic." This practice, including the systematic examination for arsenic, has been followed by this firm for many years.

Hydrochloric acid and phosphoric acid are similarly tested, and the results similarly recorded.

I was informed that the phosphoric acid used commonly contained minute traces of arsenic, although it has lately been supplied much purer than was formerly the case. Occasionally consignments of phosphoric acid have been rejected as containing more arsenic than is considered admissible.

Storage of acids.—At one works I found that all acids when brought into the works are placed in a pen, the gate of which is locked, and the key given to the chemist; after he has tested the acid for arsenic, and found it pure, he affixes a label to each carboy to show it has passed his test, and gives the key to the foreman, who can then use the acid; but if in carrying the carboy from the pen to the inverting room the label becomes detached or torn off, the carboy is returned unused to be analysed and labelled again; the foreman in the inverting room not being allowed to use any carboy without the chemist's label being attached.

The two manufactories above mentioned are the only ones which I have visited at which syrups of this kind are prepared, and I am unable to say whether precautions against arsenic similar to those which I have detailed are in general use by other manufacturers in this country. Mr. Lyle informs me that the total number of such manufactories in this country is small—he knew of only five altogether. All are large firms.

Treacle, and golden syrup manufactured abroad, are also imported into this country from America. I have not obtained any particulars as to the mode of preparations of such imported syrups, or as to the precautions taken to prevent contamination by arsenic.

It is noteworthy that it is the custom of confectionery and other firms to purchase golden syrup wholesale, and to retail it, with or without the addition of flavouring essences, either in the condition in which it is bought, or after dilution with glucose.

At one large firm where this was practised, no steps had been taken at any time by the firm to ascertain whether precautions against arsenic were being adopted by manufacturers of the golden syrup, or whether the syrup supplied was free from arsenic. This firm manufactures a "syrup," in which 15 per cent. of glucose is added to the golden syrup purchased—the product being sold as "golden syrup containing 15 per cent. of glucose." The glucose used was American liquid glucose, and similarly no precautions had been taken to ascertain its freedom from arsenic.

As regards syrups of class (b), in which the principal constituent is liquid glucose, it is probable that the addition of glucose to a substance sold as "golden syrup" or "treacle," would be held to be an offence under the Sale of Food and Drugs Acts, on the ground that the substance demanded by the purchaser under these names is solely a cane sugar product. No such understanding, however, is implied if the article is sold under the name of "table syrup," "amber syrup," or some similar designation.

I have not met with any manufactories at which a mainly glucose table syrup is prepared, and hence I am unable to indicate what precautions against arsenic are taken in purchasing the glucose used. Table syrups consisting mainly of glucose are principally made by firms who purchase golden syrups (chiefly or entirely a cane sugar product), to which they add variable but large amounts of liquid glucose.

The quantities of glucose which occasionally are employed are illustrated by certain recent prosecutions, in which a mainly glucose syrup was sold as golden syrup or as treacle. For example, on December 19th, 1901 ("Food Journal," January, 1902, p. 18), a grocer was summoned at Southwark for selling as golden syrup a substance containing 15 per cent. cane sugar and 85 per cent. of starch glucose, and was fined 5s. and costs. At Fenton, on April 30th 1902 ("Food Journal" May, 1902, p. 117), a retailer was summoned for selling as treacle a substance which contained 70 per cent. of glucose, and was fined 20s.

Presence of Arsenic in Golden Syrup.

From the analysts' returns sent into the Commission I find that Dr. Parkes, of Chelsea, and Mr. Embrey, of Gloucester, have both found traces of arsenic in golden syrup, but no quantitative results are reported.

SUGAR.

I have referred in Section I. to the liability of raw (unrefined) sugar to contain small quantities of arsenic. Such arsenic may, however, be removed almost entirely in the process of refining. Mr. Lyle, who has given considerable attention to this matter, informed me that his firm was satisfied as the result of numerous experiments, that in the refining process as adopted at his works nearly all the arsenic in raw sugar is removed, and that this applied equally to other sugar factories in this country. The sugar, after crystallisation and recrystallisation, even when obtained from raw sugar containing such appreciable quantities of arsenic as 1-140th grain per lb., failed to show more arsenic than 1 part in 20,000,000 (about one 2800th grain per lb.). It had been found that the bulk of the arsenic in such cases remained in the residual molasses, which, at these works, is disposed of to distillers.

Although Mr. Lyle had no reason to believe that arsenic would come over in distillation, he had taken the precaution of ascertaining that the distillers to whom he sold molasses of this character did not propose to utilise them for making spirit for drinking purposes.

He added that the experience of the firm's laboratory was to the effect that any arsenic which had escaped removal in the process of crystallisation would probably be reduced by the subsequent filtration through charcoal.

An instance has come to my knowledge in which the chemical adviser of a large firm of English sugar refiners analysed a number of samples, selected as representing refined sugar of different origin, English and foreign, for arsenic. The results, so far as regards loaf sugar or brown sugar from English refineries, accorded with the statement made to me by Mr. Lyle: the largest amount of arsenic in any instance being estimated as no more the 1-1000th grain to the pound. In the case of brown sugar coming from various parts of the West Indies, however, the amount of arsenic determined was, in some instances, larger than had been anticipated. Many samples appeared to be completely free from arsenic when a Marsh Berzelius test was used, which was capable of detecting 1-1000th grain to the pound. A few, however, contained amounts such as 1-300th grain of arsenic to the pound, while five samples of different origin contained from about 1-70th to 1-50th grain of arsenic to the pound.

These tests have only recently been made, and I have not yet obtained any certain information as to the manner in which particular West Indian brown sugars may receive the larger proportions of arsenic referred to. The results that I have seen suggest that the liability arises only in the case of certain factories, and does not necessarily accompany the process of manufacture as generally carried out in the West Indies.

I have mentioned the use of sulphuric acid as a colouring matter of West Indian sugars. Another colouring matter, the use of which in these sugars was considered by the Departmental Committee on Food Preservatives, is chloride of tin, and it is possible that this salt, as obtained commercially, may contain arsenic.

I am informed also that in the process of manufacturing West Indian brown sugar, large quantities of phosphoric acid may be used to precipitate lime salts. This practice would occasion risk of arsenical contamination in the absence of suitable precautions.

GELATINE.

No information has come to my knowledge, from the Public Analysts' returns or otherwise, that arsenic has been looked for or detected in gelatine; but, having regard to the extensive use of mineral acids in its preparation, I have made a few inquiries concerning its manufacture, and for this purpose visited the works of two important gelatine manufacturers—A and B.

At the places visited, gelatine is made in three ways:—

(a) Without the use of mineral acid—by the action of lime and then of caustic soda on hides which are subquently washed and boiled. In this process the hides are soaked in lime for 10 days, then cleaned and washed; they are then cut up into small pieces and soaked in caustic soda, again well washed, heated with water in steam jacketed vats, the resulting liquor being eventually evaporated in vacuum pans to the proper consistency and poured on to glass slabs to cool.

(b) By the action, first of lime, and then of hydrochloric acid, on hides, which are afterwards washed and boiled. In this process the hides are soaked for 14 weeks in a solution of lime; they are then washed and treated with hydrochloric acid and water, 120lbs. of acid to 3 tons of hides. The hides remain in the acid water 48 hours; they are then washed with water (but not with alkali) to remove the acid, boiled, the liquor evaporated, and cooled in pans.

(c) By the action of hydrochloric acid on bones. In this process the bones are put into large vats, and a solution of hydrochloric acid (proportion not given) poured on to them. They are left to soak till all the lime salts are dissolved out of the bones; the resulting "osseine" is then washed and treated with caustic soda in the same way as the hides in the second part of the process (a).

Assuming that a highly arsenical acid were used in the preparation of gelatine by the process b and c above, it would seem probable that the risks of arsenic reaching the finished product is largely diminished by the treatment employed after the acid has been added.

At neither of these works had the question of contamination of gelatine by arsenic contained in the acid arisen. At manufacturer A's the acid was bought as "chemically pure," but it had never been tested. At manufacturer B's the acid was neither guaranteed nor tested.

I understand that the bulk of gelatine used by confectioners in this country is imported from abroad.

The pure white colour of the German gelatine, so much used and asked for by makers of confectionery and table jellies in this country, is produced by the direct addition of sulphurous acid to the finished product.

A sample of gelatine taken at the works of manufacturer B, and also a sample of German make which I obtained, have been sent to Dr. McGowan, who has also had samples of gelatine, prepared for making into table jellies, from Messrs. A. Dr. McGowan's report on the samples is not yet to hand.*

JAMS AND MARMALADE.

Various witnesses before the Commission have stated that they examined jams for arsenic after the 1900 epidemic with negative results, and similar statements appear in the returns made by several public analysts to the Commission. Nevertheless, it appeared desirable to make some enquiries as to the precautions taken at jam factories with regard to the purity and the quantity of the glucose employed. For this purpose I visited five London factories and one in Bristol.

Jams may be divided into—

(*a*) Those made exclusively with cane or beet sugar.

(*b*) Those made with cane sugar with the addition of varying amounts of glucose.

In the latter class the proportion of glucose used appears to be determined by various conditions such as the nature of the fruit and its degree of ripeness. Such amounts as from 5 to 10 per cent. are common. The principal object of the glucose is said to be for clarifying purposes, to prevent the jam from crystallising.

It is said that satisfactory jam cannot be made if glucose preponderates over the sugar, and that if more than 20 or 25 per cent. of glucose be added, the jam would require so much boiling that the fruit would

* Since the above was written Dr. McGowan has reported on these samples (Appendix 25). It will be seen that gelatine from Messrs. B., who took no precautions with regard to their acid, contained most arsenic—1-140th gr. per lb. —H. H. S., July 1903.

Appendix 24.

blacken. The fluctuations in price of glucose doubtless influence its employment in jam.

It is evident that the presence in glucose of such amounts of arsenic as have been occasionally determined in glucose other than Bostock's (for example: 0·9 grain per lb.), would cause an objectionable quantity of arsenic to be introduced into jam or marmalade containing these larger proportions of glucose.

Precautions with regard to glucose.—I have not learnt that glucose was tested for arsenic by any jam manufacturer before the 1900 epidemic. Since then the firms visited as a rule have purchased their glucose with a guarantee of its freedom from arsenic, given in the more or less exact way mentioned in Section I. under the heading Glucose, but in two cases this precaution had been omitted. Similarly the precaution of having the glucose analysed had been adopted more or less systematically by some firms, and had been omitted by others.

The glucose used at all the works visited was liquid glucose of American manufacture.

CONFECTIONERY.

Various witnesses to the Commission stated that after the 1900 epidemic they examined several samples of sweets with negative results; several analysts who have made returns to the Commission make a similar statement. The detection of arsenic in sweets has been reported in one or two instances; for example, in returns made to the Commission by the Public Analysts, Mr. Brierley reports "a trace" in highly coloured sweets, and Mr. Angell "a trace," or ·0105gr. per lb. in another sample of sweets.

I visited eight large firms manufacturing sweetmeats, with reference to the use of ingredients liable to contain arsenic, and precautions taken.

Glucose is used in sweets partly for sweetening purposes, but mainly to prevent crystallisation of cane sugar; the quantity used of course varies with the class of sweet; some such as chocolate and other "creams" consist largely of glucose. The average quantity in sweets of all kinds taken together may be judged to some extent from the calculations on which claims for rebate of duty on exported goods are based. At three firms which gave me information on this point the proportions of glucose were estimated respectively as 20 per cent., 15 per cent., and 33 per cent. Another firm estimated its "heavy confectionery" as containing 15 per cent., and its "light confectionery" 40 per cent. It is evident, therefore, that if glucose used in confectionery were to contain even such amounts of arsenic as have been occasionally determined in samples other than Bostock's, objectionable quantities of arsenic might in this way be introduced.

At the firms visited the glucose principally employed was liquid glucose of American origin. Solid glucose of German manufacture is preferred on account of its greater density in certain kinds of sweets. At one firm they have lately left off using American glucose, and now only use German.

Particulars of the precautions now being taken by confectioners visited to guard against arsenic in glucose have already been indicated in Section I., under the heading "Glucose."

Invert sugar used in sweet-making, unlike brewers' invert sugar, is not purchased as such, the inversion being carried out by the sweet manufacturer on his premises. I met with no instance in which sugar for sweet-making is inverted by the addition of a mineral acid. Cream of tartar and citric acid are commonly employed; or reliance is placed on prolonged boiling as sufficient to bring about the required inversion.

Citric and tartaric acids are likewise used as flavouring for acid sweets; but the proportion is small. These acids were in all cases stated to be bought with a guarantee or with an assurance of their purity. Such guarantees sometimes state specifically that the substances are free from lead, and at one of the firms lead was occasionally looked for by the works chemist. None of the guarantees made specific mention of arsenic, and I did not learn of any instance in which arsenic had been looked for in citric or tartaric acid at the instance of any sweetmeat manufacturer. As above indicated, however, there is little reason to suppose that material quantities of arsenic could be introduced into sweets by these acids.

Glycerine is used in making certain forms of jujubes, and occasionally for other purposes, such as the treatment of vanilla. The quantity of glycerine in jujubes at one works was stated to be 10 per cent. If arsenical glycerine, such as referred to in Section I. above, were employed, it is evident that objectionable quantities of arsenic might be introduced in this way. To take an extreme instance, glycerine containing 4 grains of arsenic to the lb., such as was found by Mr. Fairley in 1894, would introduce 2·5ths of a grain of arsenic to the lb. of the sweets in question.

On the other hand, quantities of arsenic such as those found by Dr. Campbell Brown in recent samples of glycerine the highest of which is about one 13th of a grain to the lb., would not introduce more than one 130th of a grain of arsenic to the lb. of such sweets.

Beyond stipulating in general terms for "pure" glycerine, the manufacturers I visited had taken no precautions to secure its freedom from arsenic, and indeed the liability of glycerine to arsenical contamination did not appear to be known to them.

Gelatine.—Certain kinds of soft sweets, called in the trade "Jellies," consist almost wholly of gelatine; the gelatine used at the works visited was imported gelatine. No question of testing this gelatine for arsenic had arisen in any instance.

Colouring Matters.—I have dealt below with the possibility of arsenic being introduced by means of colouring matters used in food, and with precautions taken with regard to them. I may here note, however, that oxide of iron (which is liable to be contaminated by arsenic to a high degree) is employed to give a brown colour to cheap chocolate and certain other kinds of sweets.* In one instance (report of Departmental Committee on Preservatives and Colouring Matters) 35 grains of oxide of iron were used to the lb. of burnt almonds.

Dextrine.—At the works visited it was stated that no gummy substances which have been prepared from the action of mineral acid upon starch are used. The gummy ingredient of pastilles and the like is said to be gum acacia of natural origin.

Substitute for Cocoa-butter.

Cocoa-butter is used largely in the manufacture of chocolate, and for other confectionery purposes. It is also sometimes used in making certain kinds of pastry, and is added in the process of sugar refining in order to prevent frothing of the sugar solution.

Information was recently given me that a wool oil, known in the trade as "brown wool-grease," and prepared from sheep's wool, had in one instance been sold to a large firm of sugar refiners under the name of "cocoa-butter." The refiner said that he recognised that this wool-grease was not true cocoa-butter, but considered that it was suitable for his purpose. Subsequent to its use being discontinued for commercial reasons, it was found that this wool-grease or so-called cocoa-butter contained about ·14 grain of arsenic per lb.

I understand that it is not generally recognised by manufacturers or users of cocoa-butter that a wool-grease is or may be sold as being cocoa-butter; and, in point of fact, the above is the only instance in which I have heard of its use.

I visited a manufacturer of brown wool-grease and lanoline, and by him was informed that in his view no opportunity of arsenical contamination was afforded by the processes used to obtain these substances from the wool. He was not aware of the fact that such grease might contain arsenic, but was of opinion that its presence could be accounted for by the use of arsenical sheep dip; the arsenic in the wool not having been sufficiently removed by the process of washing.

He also informed me that "lanoline," which is used chiefly for pharmaceutical and toilet purposes, receives considerably more washing than brown wool-grease. The firm of sugar refiners above referred to had caused a sample of lanoline, which they had for a time used for the same purpose as the cocoa-butter, to be tested for arsenic. It contained ·0035 grain of arsenic per lb. I have not heard of any other samples of lanoline that have been tested for arsenic.

If wool-grease more or less purified is liable to be used by confectioners or other food producers, or in future comes to be used by them as a substitute for true cocoa-butter, it is clearly important that attention should be paid to the question of arsenic, the more so if the origin of arsenic is, as suggested, sheep dip, for it is evident that under particular circumstances the quantity of arsenic thus introduced into the wool might be considerable.

* Now see report by Mr. Otto Hehner (Appendix 27), which refers to the estimation of arsenic in coloured sweets.—H.H.S., July 1903.

Liquorice.

Mr. W. Thomson stated in his return to the Commission that he had found arsenic in a sample of liquorice jujubes. He has since written that the quantity was approximately 1-35th grain to the lb. Such jujubes would probably be prepared with a considerable proportion of glucose. That the origin of the arsenic may however have been the liquorice itself is shown by the fact that Mr. Thomson found 1-70gr. of arsenic per lb. in a sample of a stick ("Spanish juice"), into the preparation of which probably no glucose had entered. A sample of raw liquorice which I took haphazard at a confectioner's was found by Dr. McGowan to contain one 245th of a grain of arsenic per lb.

Two main classes of liquorice juice are imported into this country: the first is Italian juice, which contains a considerable quantity of sugar, and can be eaten without treatment. This is considered the best, and is simply the evaporated extract of the root without any added sugar or glucose. The other juice is imported chiefly from Russia, and some from Turkey; it contains little or no natural sugar, and is mixed in this country with sugar to make hard liquorice; and with sugar or glucose and flour, and in some cases glycerine to make soft liquorice. I was informed that sulphuric acid was also sometimes added to give a bright appearance to the liquorice.

I have been further informed by Dr. Hillaby, Medical Officer of Health for Pontefract, that glucose can be used in "liquorice goods" to the extent of about 35 per cent., and that glycerine is used by some makers, but that "good glycerine" is too expensive for general use. The points just referred to, however, although they show several ways in which arsenic might be introduced into manufactured liquorice, do not suffice to explain the small quantities of arsenic found by Mr. Thomson and by Dr. McGowan in the crude liquorice—unless it was due to sulphuric acid.

CIDER.

I have not heard of any instance in which arsenic has been detected in cider. None of the public analysts who have made returns to the Commission mention that they have examined cider for arsenic. In view of statements that invert sugar is used in the manufacture of cider, however, I have made a few inquiries of cider manufacturers. Mr. Symons, the proprietor of Messrs. Symons and Co., informed me that he used invert sugar only at certain seasons of the year, and under certain conditions, and that such sugar was inverted at his works by means of tartaric acid; he did not employ hydrochloric or sulphuric acid for the purpose.

At Bristol, the representative of Messrs. Woolway and Coleridge informed me that no invert sugar was used in their business, but that caramel was used for colouring cider. On the other hand, it is a fact that brewing sugar manufacturers supply brewers' invert sugar to cider manufacturers. The precautions against arsenic which are now adopted in manufacturing these brewing ingredients would presumably afford security to the cider manufacturer who procures invert sugar in this way.

I have not heard of other ingredients of cider which are likely to render it liable to arsenical contamination, and, therefore, I have not made detailed inquiry into the process of its manufacture.

I understand that no brewers' or distillers' yeast is used in cider making. The addition of glycerine to American ciders was referred to by Dr. Voelcker in his evidence to the Departmental Committee on Food Preservatives; he was not able, however, to state the quantity of glycerine present in the samples examined. It is stated that glucose is of no value as an ingredient in the manufacture of cider.

Mr. Radcliffe Cooke in his evidence before the same Committee (Q. 6582), states that "Walter Gregory's Powder," a mixture of oxide of iron and salicylic acid, is sometimes added to cider.

HERB BEER.

In order to ascertain whether glucose or brewers' invert sugar is used in the preparation of this sort of fermented beverage I made some inquiry of Messrs. Youngs at the Botanic Brewery, Bermondsey, who informed me that in view of the necessity of keeping the quantity of alcohol in these beverages below the limits permitted by excise regulations, there is no advantage in the employment of either of these substances. The herb beer manufactured at these works was prepared by fermenting a weak solution of cane sugar, to which saccharine and herbs are added. Appendix 24.

TEMPERANCE DRINKS.

No information has been received by the Commission that arsenic has been detected in mineral waters or other temperance drinks, and it would appear from the Public Analyst's return to the Commission that drinks of this class were rather extensively examined for arsenic after the Manchester epidemic. The possibility of arsenical contamination of these drinks, however was referred to by certain witnesses (including Dr. Niven and Mr. Salamon) in their evidence to the Commission. With reference to this I visited three firms in London, two in Manchester, and one in Bristol.

It will be useful to deal with temperance drinks by adopting the classification used in the trade—namely:—

(a) Mineral or aerated waters.

(b) Aerated sweet waters.

(c) Brewed beverages.

(d) "Fruit syrups," sold as such for adding to soda water or to plain water, either hot or cold.

(e) "Crystals," or other powders, sold as such for making various "summer beverages."

(a) *Mineral Waters,*" such as soda, seltzer, or lithia waters, are simply water charged with carbonic acid gas, to which certain salts are added—*e.g.*, carbonate of soda or lithia. Phosphates are sometimes used in the preparation of seltzer water. The amount would be small, from ½gr. to 2grs. to the pint (Kirkby). The carbonic dioxide is usually produced from sulphuric acid and carbonate of lime or soda. The gas is then twice washed, and goes either into a gas-holder, or it is forced direct into the bottle containing the water to be aerated. It is claimed that by this washing any arsenic that might be present would be removed.* In some works the carbonic acid was bought compressed in bottles obtained from the Carbonic Acid Gas Company at Lea Bridge.

On one occasion Dr. Teed (analyst to Messrs. White and Co.), when testing mineral water manufactured by another firm, found free sulphuric acid, which might have been added for the purpose of acidifying the water, but he did not think the addition of free acid was a common practice. He had not tested the sample in question for arsenic. Messrs. Cazenove and Nicolle ("Analyst," 1892, p. 118) state that "aerated waters may contain free sulphuric acid mechanically carried over from the generator," and this, perhaps, explains the origin of the sulphuric acid in this case.

(b) *Aerated Sweet Waters,* such as lemonade, gingerade, kaola, champagne cider, etc., are waters aerated with carbonic acid gas, sweetened with syrups, and flavoured with coloured essences. In all these cases the syrups are said to be made from pure cane or beet sugar; in some cases they contain saccharin. It was stated at the places visited that no glucose was contained in these syrups.

Mr. Kirkby (of Messrs. Jewsbury and Brown) informed me that glucose would not make so good a syrup, as it is liable to ferment, and would require preservatives.

In order to give a sharpness to the taste of sweet waters it is the custom at some works to add phosphoric acid, or the substance known as "phospho citric acid" (Section I.). The proportion added is probably small, but, though I have been told of its employment, I have not visited any firm where I could obtain particulars as to its use.

In the case of lemonade, citric acid may be added.

I was informed at Messrs. White's that glycerine was at one time used to sweeten aerated waters, but that its use was now discontinued. And I did not hear of its use at any of the works visited, except that a very small amount was used in Kops ale. I have been given a sample of a French preparation called Porcherine, which appears to consist mainly of glycerine, and is being recommended for sweetening aerated waters; but

* In connection with this process, Mr. Marshall, of Rochdale, informed me that early during the Manchester epidemic he was consulted by a mineral water maker, who was using a clear Nicholson's sulphuric acid to generate his carbonic acid. Mr. Marshall examined this sulphuric acid, which was highly arsenical. He then examined the mineral waters which he found quite free from arsenic. This acid was subsequently withdrawn by Messrs. Nicholson.

Appendix 24. I did not find that it was being used at any of the works I visited.

(c) *Brewed Beverages*, such as "hop ale," "non-intoxicating stout, "ginger beer," etc., are all made by a fermentation process. As a rule, the substance fermented is cane or beet sugar, to which may be added ginger, hops, or hop essence, etc., or malt in some form, according to the character of the beverage. Saccharine may also be added, and liquorice in the case of "non-intoxicating stout."

At one works glucose was used in brewing stone ginger beer, and invert sugar in brewing other non-intoxicating beers. Mr. Kirkby, at Messrs. Jewsbury and Brown's, informed me that the amount of glucose used was very small, in order to keep down the alcohol, in the case of "stone" ginger beer being less than ¼lb. per gallon. At most of the works I visited, "stone" ginger beer was brewed, without glucose, from cane or beet sugar and ginger, and was acidulated with tartaric acid.

In one instance, a "non-intoxicating beer," the beverage consisted of a brew of invert sugar flavoured with essence of hops and coloured with caramel. This invert sugar was described to me as a "malt substitute." It was, however, ordinary brewers' invert sugar, and was bought from a large firm of sugar makers. A "non-intoxicating stout" was also made at the same works, the only difference being the addition of more caramel.

(d) *Fruit Syrups.*—These are used for mixing either with water or soda water as a summer drink, but more extensively to manufacture "hot winter drinks," such as are sold by small shop-keepers and itinerant street vendors. They usually consist of cane sugar syrup, or a mixture of cane sugar syrup with glucose, flavoured with "fruit flavouring" and coloured.

Syrups of this class, sold under such names as "lemon squash" or "lime juice cordial," are manufactured at most of the works I have visited. The fruit juice utilised appeared in all cases to be lime juice purchased either directly or through an agent from the Montserrat Lime Juice Company. This juice, when imported, contains bisulphite of lime as a preservative, and other preservatives are added by the manufacturers of the syrup in this country. I was informed that neither citric acid, tartaric acid, nor mineral acid are added to these "lemon" or "lime juice" syrups.

(e) *Crystals or Other Powders Sold for Making Drinks.*—I include under this head various powdered and crystalline materials sold as "fruit or lemon crystals," "lemonade powders," "sherbet," "seidlitz powders," etc. Fruit crystals are a mixture of cane sugar with a small proportion of citric acid crystals, flavoured with fruit essences, which are either made from fruit or obtained synthetically. The proportion of citric acid in the drink prepared from these fruit crystals is said to be very small. Lemonade powders of the kind now extensively sold and advertised are essentially a dry mixture of cane or beet sugar with citric and tartaric acids, and flavoured with oil of lemon. Citric or tartaric acid may form about half the bulk of such powders. About 2oz. of the powder is commonly used to the pint of water to make a syrup, and two tablespoonfuls of this syrup make half a pint of the drink; in other words, the drink lemonade will contain about 4-5th oz. of the lemonade powder per gallon, a large portion of which would consist of citric and tartaric acids. Sherbet contains powdered sugar, together with citric or tartaric acid, or both, and carbonate of soda. It is flavoured, as a rule, with essence of lemon. From 10 per cent. to 20 per cent. of tartaric acid appears to be an ordinary quantity in sherbet. A pint of sherbet would be made from about ½oz. of the powder, and may contain, therefore, from 48 to 24 grains of tartaric acid. The quantity of tartaric or citric acid used in a drink made from a Seidlitz powder may be taken as from 30 to 40 grains.

Precautions with Regard to Arsenic Taken in the Manufacture of the Various Drink Substances Above Mentioned.

Sulphuric acid being used solely to manufacture carbonic dioxide gas, the risk of arsenical contamination of aerated waters by this means is small, even if a strongly arsenical acid were used. I found, however, that since the Manchester epidemic certain firms of mineral water makers had caused occasional samples of their sulphuric acid to be tested for arsenic.

At Messrs. Jewsbury and Browns', who manufacture other articles beside aerated water, it has been the custom for over twenty years to test for arsenic all carboys of sulphuric acid purchased, and to record the result of the test.

Glucose.—It is evident that the quantity of glucose used occasionally in *brewed* temperance beverages would be sufficient to cause objectionable contamination by arsenic, if the glucose used was seriously contaminated. A quarter of a lb. of Bostock's glucose, containing 4 grains of arsenic per lb., might introduce about 1 grain of arsenic to the gallon of ginger beer brewed with it. If the glucose contained arsenic to the amount which has occasionally been found in non-Bostock samples—for example, 1-10th grain per lb., the ginger beer might be contaminated to the extent of 1-40th grain per gallon. Similar considerations apply to the use of brewers' *invert sugar* in brewed temperance beverages.

The degree of possible contamination of aerated sweet waters and other beverages made from syrup containing glucose is obviously much less than in the last case, as the amount of syrup which enters into the composition of the actual drink is relatively small.

Phosphoric Acid used in mineral-water making appears to be "commercial" acid, which, as mentioned in Section I., is liable to contain arsenic. The quantity of phosphoric acid used is so small that there is little risk of the introduction of material quantities of arsenic into temperance drinks in this way. Whether any manufacturers make a practice of checking the purity of the phosphoric acid as regards arsenic I am unable to say.

I did not ascertain at any of the works visited that either *citric* or *tartaric* acids have been examined specifically for arsenic, or that any demand has been made in purchasing these substances that they should be free from arsenic. As has been said above, guarantees of freedom from lead are given by the manufacturers if required by the purchaser. At those works where I made inquiries on the point, I was informed that the manufacturer had not considered it necessary to check the correctness of this guarantee by analysis. For citric or tartaric acids to introduce a noteworthy quantity of arsenic into temperance beverages, such as those mentioned above, it would be necessary that the contamination of the acid by arsenic should be of a very high order. For example, assuming that the liquid "sherbet" contained 1-100th grain of arsenic in a pint (or 2·25th grain of arsenic per gallon), as a result of contaminated tartaric acid present in the sherbet powder, the tartaric acid must have contained as much as 1·6 grains to the lb. I have no evidence that tartaric acid has in fact been found contaminated to this extent.

I would here note that I had every assistance from the various temperance drink manufacturers, except from Messrs. Batey and Co., who, with the exception of stating that they used no glucose, would give me no information whatever.

BRITISH WINES.

Four firms which I visited manufactured British wines, and by one of these glucose is used at certain periods of the year, but in small quantity. The firm in question obtained American liquid glucose, once guaranteed free from arsenic, but not tested by themselves. It will be remembered that Mr. Wa[illegible] (Q. 7443) stated that glucose is largely used in France to improve the quality of inferior vintages of clarets, and manufacturers of British wines have told me the same thing.

BREAD, CAKES, AND BISCUITS.

Although no evidence has been received by the Commission that any noteworthy amount of arsenic has been found in bread, yet the presence of minute quantities in bread has been referred to by Professor Delépine (Q. 5270 and 5280), and the matter seemed to call for some inquiry. I have visited several manufacturers of bread, cake, and biscuits in London and elsewhere on this point, and I have also received information from Mr. Goodfellow, who is chemical adviser to the Confectioners' Union.

The liability of bread, cake, and biscuits to contain arsenic seems to arise from the use of the following substances: Yeast, glycerine, glucose, "malt extracts," baking powders, dextrine.

Yeast.—Many witnesses have given evidence to the Commission as to the affinity of yeast for arsenic. In five samples of bakers' yeast, not from breweries, and having no relation with Bostock's sugar, the quantity of arsenic estimated by Professor Delépine was from about 1-60th to about 1-20th grain per lb. From the returns obtained from public analysts, it appears that Mr. White, of Derbyshire, and Professor Campbell Brown between them examined 53 samples of yeast (whether derived from breweries is not stated), of which 44 were arsenical. The largest quantity of arsenic, about 3-40ths grain per lb., was determined by Professor Campbell Brown. I understand that in consequence of the shorter hours of labour in bakeries very little brewers' yeast is now used in baking. Of the firms I visited, only one used brewers' yeast, and in that case it was sometimes mixed with distillers' yeast. The yeast now employed is generally pressed yeast, obtained through merchants, and comes either from distilleries in the United Kingdom or from the Continent. I have no evidence that distillers' yeast is less liable to arsenical contamination than brewers' yeast; indeed, having regard to the precautions against arsenic now generally adopted by brewers, it is not unlikely that brewers' yeast at the present time is the better of the two in this respect. Early in 1902 Mr. Heron found so much arsenic in a sample of distillers' yeast that he thought it necessary to warn the merchant who brought it to him that it should not be sold. He did not, however, tell me the actual quantity of arsenic in this particular sample. Apart from this instance, I have not heard of any cases where distillers or yeast merchants have taken steps to ascertain the condition of their yeast as regards arsenic. My information on this point comes from several large firms.

The quantity of yeast which is added to bread is, of course, small; 1lb. of yeast to 280lbs. of flour and 5 gallons of water is the usual proportion.

Glycerine.—This is largely used in the manufacture of cakes, chiefly of the cheaper sorts, and is put into them for the purpose of keeping them moist. The amount varies. Thus one firm used 1½lbs. glycerine to 100lbs. of mixing; at another they used 2lbs. to 3lbs. of glycerine to 100lbs. of mixing; in the latter case the completed cake would contain 2lbs. of glycerine in every 50lbs. of cake. In certain "gluten biscuits," for diabetic patients, about the same quantity (2½lbs. glycerine to 100lbs. of mixing) is used.

I am informed by Mr. Goodfellow that glycerine may be used in bread baking, but he is not aware of its use in any instance at the present time.

Glucose.—Glucose does not appear to be used in the manufacture of cakes. It is, however, a frequent ingredient in the manufacture of what is termed "hard dough" for making a certain class of biscuits. One of the objects of the glucose is to impart a fresh-looking appearance to the biscuit. The proportion of glucose was given me as 6lbs. of glucose to 1 sack of flour producing 360lbs. of biscuit. One firm which I visited informed me that they had given up the use of glucose in biscuits since the Manchester epidemic. As regards bread, the use of glucose is mainly as a "yeast food"—*i.e.*, a food material on which yeast will act with greater facility than in the case of starch. These yeast foods are sometimes sold to bakers under the name of "malt extracts." True malt extract is also largely used in the baking trade as a yeast food, while several so-called malt extracts consist partly of glucose and partly of true malt extract. Some, however, contain no true malt extract at all. One such, I am informed, consists of glucose, pea flour, cane sugar, and phosphates. Another, sold as "super-malt," and very largely used, is said similarly to contain no true malt extract. Malt extracts or yeast foods are ordinarily employed in bread-making to the extent of about 1lb. of extract to 280lbs. of flour.

Golden Syrup is used in the manufacture of certain biscuits, such as gingerbread nuts. At one manufactory two kinds of syrup were used for this purpose, Lyle's golden syrup for the better class of nuts, and another syrup (purchased through a merchant), the origin of which was unknown to the manufacturer, for cheaper kinds of nuts.

Baking Powders.—In biscuit and cake making these powders are made according to a variety of recipes. The ingredients are generally cream of tartar and tartaric acid, along with carbonate of soda or carbonate of ammonia, or frequently the two former substances are replaced wholly or partly by acid phosphates, which are much cheaper. It is occasionally the custom to substitute hydrochloric acid for tartaric acid in making puff paste and other articles for which rapid evolution of gas is required.

Frequently the necessary powders are added direct to the flour, without having first been made up into a baking powder. Baking powders containing acid phosphates, and sold under various names, such as "cream substitute," etc., appear to be not infrequently arsenical. A powder of this kind in use at a cake-maker's, collected by me and analysed by Dr. McGowan, showed 1-39th grain of arsenic per lb. Mr. Ballantyne, chemist of the Hovis Flour Company, informed me that he recently reported against a sample of phosphate supplied to him for making baking powder, which showed immediate evidence of arsenic with the Reinsch test. A large wholesale chemical manufacturer informed me that he had refused to quote for a cheap phosphatic baking powder on account of the considerable quantities of arsenic which in his view it was necessarily liable to contain.

Egg Powders, Self-raising Flours, Cake Flours, Custard Powder, etc., usually consist of baking powder of one or another kind, mixed with flour, and coloured commonly with saffron yellow.

Mr. Gatehouse, of Bath, informs the Commission, in his analyst's return, that some four years ago he found arsenic in a specimen of egg-powder. He suspected, however, that the origin of the arsenic might have been a pink aniline dye contained in the powder.

Dextrin.—I met with a particular biscuit made from flour to which is added 1 per cent. of a liquid solution of dextrin, made from German farina by the addition of hydrochloric acid.

Summary.

It is evident from the foregoing that in general the degree to which cakes, biscuits, and bread are liable to arsenical contamination may be regarded as small. Taking, for example, yeast containing as much as one-third of a grain arsenic per lb., it would be unlikely that 1lb. of bread made from it would contain in consequence more than 1-1000th grain of arsenic.

Assuming chemical substances (for example, phosphates or hydrochloric acid) used in baking to contain 1 grain of arsenic to the lb., cake or biscuits made with it would not be contaminated with more than about 1-100th grain of arsenic per lb. of finished product. Taking the proportion given above, where glucose was used in biscuit-making to the extent of 1lb. in 60lbs., and assuming that the glucose was contaminated to the extent of 1-10th grain of arsenic per lb., the quantity of arsenic which would reach the biscuits in this way would be 1-600th grain of arsenic per lb. of biscuits. A Bostock glucose containing 4 grains of arsenic to the lb. would in this case introduce no more than 1-15th grain of arsenic per lb. of biscuits. At the same time it is not unlikely that considerably larger quantities of glucose may be used than was stated to be the case at the works I visited.

If the glycerine used in cakes was as arsenical as some of the examples referred to in Section I., the degree of contamination would be more serious. In the extreme instance of glycerine containing 4 grains of arsenic to the lb. (such as found by Mr. Fairley in 1894), then, taking the proportions used at one of the works which I visited, 1-6th grain of arsenic might be introduced by this means into 1lb. of cake. On the other hand, quantities of arsenic such as those found by Dr. Campbell Brown in recent samples of glycerine (up to 1-13th grain per lb.), would not introduce more than 1-325th grain of arsenic to the lb. of cake.

It may be said in general that precautions against the introduction of arsenic in the ways above indicated are seldom taken by the manufacturers. In two instances I found that biscuit bakers using glucose at the time of the Manchester epidemic had caused their glucose to be analysed. With one exception, I heard of no instances in which baking powders, malt foods, or yeast had been examined for arsenic at the instance of the manufacturer, or were specifically required to be free from arsenic; but I understand certain firms in purchasing the ingredients for baking powders make a general stipulation that they should be "chemically pure."

Glycerine at one cake manufacturers was purchased direct from the makers as "confectioner's glycerine," and was guaranteed by the maker to conform to all the tests of the British Pharmacopœia. I have not, however, met with any manufacturer who has suspected that any risk of arsenical contamination of his product arose from the use of glycerine. The information given by Mr. Moore, that glycerine is frequently sold without its origin being known to the purchaser, is important

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in this connection, and it would seem very desirable that the cake manufacturer should invariably take effective precautions to secure the absence of arsenic from all the glycerine which he uses.

MEAT EXTRACTS.

For the purposes of this report, meat extracts may be classed under three heads, namely:—

(a) Those prepared without the use of mineral acid.

(b) Those in the preparation of which mineral acid is used, and

(c) Extracts of foreign manufacture, the process of preparation of which does not appear to be known to the agents of the manufacturers in this country.

The large majority of meat extracts, such as the Bovril and Liebig Companies' products, Brand's Essence of Beef, Hipi, Mutton Essence, etc., come in the first category. Their manufacture in the first instance is commenced either in America or New Zealand. The extract is obtained by a process of treating fresh meat and water with gentle heat, *e.g.*, 135° F., and evaporating. On arrival in this country the "extractum carnis," as it is called, is manipulated and converted into different finished products by varying treatment in the matter of concentration, dilution, addition of salt, and the like. None of these additions, so far as I have been able to ascertain, involve risk of introduction of arsenic, with the exception of glycerine, which is added to certain preparations, in one instance to the extent of 22·5 per cent. I learn that this is the view taken by Mr. Hehner, who is chemical adviser to various meat extract firms, and who has tested certain samples of meat extracts for arsenic, always with negative results.

Mineral acids are used in the preparation of certain meat extracts, particularly those which are called "peptones." These are made by treating meat extract with calf's pancreas and hydrochloric acid. The percentage of the latter is very small. At Messrs. Brand's I was informed that only 1 drachm is utilised for 40 gallons of the finished product. Messrs. Savory and Moore informed me that hydrochloric acid is used in some of their preparations, but the firm's representative objected to give me information as to the quantities employed, or as to the precautions taken with regard to the acid. He stated, however, that pharmacopœial acid was used.

Mr. Beech (secretary of the Carnrick Company) informed me that a food called "Carnrick Liquid Peptonoids," made in America, consists of the albumen of meat, the albumen of wheat, and the digested caseine of milk. He further stated that the caseine was digested with hydrochloric acid, but he did not know in what proportions it was used, or what precautions were taken with regard to the acid.

Mr. Lewis (secretary to Messrs. Armour and Co.), informed me that no acid was used in the preparation of their extractum carnis, but was used in the preparation of "lactated pepsin," to the amount of about 1 per cent. He did not, however, know what precautions were taken with regard to the acid. Lactated pepsin, however, is more of a drug than a food.

Reference is made in "Allen's Commercial Organic Analysis," Vol. IV., p. 301, to a patent by Etienne and Delhaye, 1890, of a process by which the residue, after the liquid meat extract has been removed, is pressed and treated in the water bath with an equal weight of concentrated hydrochloric acid, in order to disintegrate the fibro-muscular tissue. The liquid is filtered, neutralised with sodium carbonate, and mixed with the extract first obtained. It is evident that if an arsenical acid were used in this process the finished product might contain notable amounts of arsenic. Mr. Hehner informs me, however, that hydrochloric acid is not used in this way to prepare meat extracts in this country.

As regards certain other forms of meat extract, I found that the process of manufacture was unknown to the English representatives on whom I called. These substances included "carnigen" and "somatose," and Valentine's meat juice.

It would seem, therefore, that meat extracts, concerning which I was able to get information, may be considered practically free from liability to arsenical contamination. In the few instances where I met with the use of hydrochloric acid, the quantity was so small that the employment of even highly arsenical acid would introduce only an infinitesimal quantity of arsenic to the finished product, and as a matter of fact at the two English firms I visited I was informed that the acid used was British Pharmacopœia acid. I did not hear of its being tested at Messrs. Savory and Moore's, but at Messrs. Brand's I was informed that the acid was guaranteed chemically pure, and subsequently to my visit a sample was analysed and reported to be free from arsenic.

As regards glycerine, however, it is evident that when such large quantities as 22½ per cent. are used, a serious degree of contamination by arsenic might arise if a highly arsenical glycerine were employed. As a matter of fact, at the Bovril Company, where this amount of glycerine is used in "Caffyn's Liquor Carnis," the glycerine is guaranteed to conform to Pharmacopœial test. The validity of this guarantee is not, however, checked by analysis.

CARNOS.

This is a food that has lately been advertised as a substitute for beef tea and for making soups.

I visited the factory (November 9th, 1901), at Grimsby, where I was informed by Mr. Overbeck, the manager and inventor of the process, that Carnos is made from six parts of yeast and one of malt culms. These substances are mixed with water and mashed, so as to enable the diastase in the malt culms to act upon the yeast. The resulting liquor is roughly filtered, boiled in a copper for three hours, filtered through filter presses, concentrated in vacuo, and then finally filtered. No mineral acid or other chemicals, except glycerine, are used in its preparation.

At the date of my visit I had obtained from Dr. McGowan the result of his analysis of a sample of Carnos, which I had purchased through a druggist in July, 1901. This sample contained 1-25th grain of arsenic per lb. There seemed little doubt that the arsenic was derived either from malt or yeast, or both.

Mr. Overbeck stated that the yeast employed is obtained from a neighbouring brewery, and the malt culms either from the maltings of that brewery or from elsewhere. At the time when the liability of malt to contain arsenic became known, the brewery in question was using malt obtained from Mr. Soames, of Grimsby, and dried over gas coke. Malt sold by this firm shortly after the 1900 epidemic has been described by Mr. R. G. Tomson, of Threlfall's Brewery, Manchester, as producing beer which had to be destroyed on account of arsenic (3094-3099). It came to Mr. Overbeck's knowledge that carnos contained an appreciable amount of arsenic, and he informed me that he took prompt measures to call in as much as he could of the carnos he had on sale at the time, and to guard against contamination in its further manufacture. After experimenting, he adopted the plan of adding to the boiling copper a solution, as I gather, of sulphuretted hydrogen in glycerine, the efficiency of this process being tested by placing two large squares of copper in the boiling vat. Mr. Overbeck claimed that if any arsenic remained unprecipitated, these strips would show a coating of arsenic. The brewery is said now to use malt dried over anthracite, and the malt culms purchased are also obtained from anthracite-dried malt.

I did not see this process in operation, as no carnos was actually being made at the time of my visit. Mr. Overbeck gave me, however, a sample of carnos (November 9th, 1901), in the preparation of which the above treatment had been applied. In this sample Dr. McGowan has found almost exactly the same amount of arsenic as was present in the sample purchased in July, 1901, which, according to Mr. Overbeck would not have been so treated. A further sample of carnos obtained from a druggist on May 14th, 1902, has been found by Dr. McGowan to contain a little over 1-6th grain of arsenic per lb.

In view of these results, I wrote on July 10th, 1902, to Mr. Overbeck, asking whether he had made any modification since my visit in 1901 in his method of treating the liquor to free it from arsenic. I also asked for a sample of the glycerine solution added for the purpose. In reply, Mr. Overbeck wrote on July 12th that he hoped I would not press him for further information, as the method he employed was a "trade secret."

If a liberal quantity of carnos was used to make soup or beef tea, say, 1oz. to the pint, and the carnos contained 1-6th grain arsenic per lb., the beef tea would be contaminated to the extent of 1-12th grain of arsenic per gallon. I have not heard of any foods or extracts

on the market, other than carnos, which consist largely of yeast. But I understand that the utilisation of yeast as a basis for prepared food has lately been receiving considerable attention.

CEREAL FOODS.

I have made some inquiries as to cereal foods, with a view to ascertain how far mineral acid or other substances liable to contain arsenic are used in their preparation. I did not hear of such ingredients being used in the majority. Ordinary flour, Hovis flour, Quaker Oats, Ridge's Food, for example, are essentially milled flours. Some are also torrified by dry heat, and some are treated by super-heated steam.

In the preparation of cornflour by one manufacturer, I was informed that soda lyes are added to get rid of the gluten, which is thus caused to float on the surface of the liquor from which it is skimmed off, the process being much the same as in the preparation of washing starch. To correct this alkalinity of the liquor, either sulphuric or hydrochloric acid is added, but the quantity employed was said to be in any case very small, although varying according to the alkalinity of the solution, generally about one or two teacupfuls to the vat being used. The acid in this instance was not guaranteed, nor had it been tested as regards arsenic.

The chemical substances which may be added to "self-raising" flour have been above alluded to.

I have been unable to obtain information as to the method of manufacture of a number of prepared cereal foods, such as shredded wheat, cream of wheat, etc., which are imported principally from America. Mr. Heron, who has made special study of starch foods, informs me that he has no reason to believe that substances liable to contain arsenic are used in their preparation.

FOODS IN WHICH MALT IS AN INGREDIENT.

Maltine and Malt Extracts.

There are several varieties of maltine and malt extracts on the market.

(*a*) French or German Extracts.

(*b*) American Extracts.

(*c*) British-made Extracts.

(*a*) I could obtain very little information as to French and German maltine, except that it was chiefly used by bakers as a yeast food, but I could learn nothing as to its manufacture.

(*b*) A large portion of the "maltines" or "malt extracts" which are sold by druggists in this country is of American manufacture. They are imported chiefly by the Maltine Manufacturing Company. I could obtain no information at the London offices of this company as to the process of manufacture of the malt, or as to the method of kilning or fuel used.

(*c*) *British-made Malt Extracts.*—I went over the works of three of the largest manufacturers of malt extract in this country. At the first they make all their own malt over specially small, hand-picked anthracite. At the second the malt is bought, but in each instance is now analysed before being used. At the third malt is specially malted for them, and it is stipulated that any malt purchased should be made over anthracite. At the time of my visit at one of the works the test used was Reinsch, which the chemist claimed would detect the presence of 1-100th grain per lb. in the malt. At another works I found samples of both the malt and the finished product had been sent to a public analyst since the Manchester epidemic, and had always been returned as free from arsenic. At the third place I was told they used a Reinsch test, but the degree of delicacy was not stated.

Presence of Arsenic in Malt Extract.

From the returns of public analysts to the Commission, I find only three had examined maltine or malt extracts at the date of their return, but none of them report any arsenic. Mr. Goodfellow informed me that out of 13 samples of malt extract for bakers' purposes examined by him, two contained arsenic, but he has not furnished me with particulars of quantities. The presence of a small amount of arsenic in maltine had been recognised in a sample tested by the chemist of Messrs. Allen and Hanbury's, early in 1900, but here again the quantity is not available.

The proportions of malt which may be used in making malt extract differed at the various firms. In one instance it was calculated that approximately 2lbs. of malt ented into 1lb of extract, so that supposing the malt were contaminated with arsenic to the extent of 1-100th grain per lb. of malt, about 1-50th grain of arsenic per lb. of extract might be introduced. Appendix 24.

Mr. Free (Messrs. Edmé) suggested that if arsenic were present in the malt it might be removed from the finished article by the process of repeated filtration adopted at his works. At Messrs. Burroughs and Wellcome I was also informed that some observations had been made which suggested that, weight for weight, malt extract may contain less arsenic than the malt it is made from. Mr. Dodd, of Allen and Hanbury's, had made a similar observation in one instance. I do not think, however, that this could safely be accepted without more extended experiment.

Malt extract being made from malt wort, I have no knowledge of any other source of arsenic but the malt: the only extraneous substance used being a small amount of dextrin.

Although Maltine and malt Extracts are known rather as a drug than as a food, they are consumed in considerable quantity over long periods by many invalids.

Other Malt Foods.

The proportion of malt used in foods such as "Allen and Hanbury's Food," "Hovis Malted Food," "Horlick's Malted Milk," "Grape Nuts," etc., is smaller than in the case of maltine, but it must be remembered that some of the foods in question are habitually consumed in large quantities as an ordinary article of diet, especially by children and invalids.

Messrs. Allen and Hanbury make a "Malt Food" by the addition of malt extract to flour: The Hovis Flour Co. make a malted food which is essentially a dried and ground wort obtained from malt and raw grain. At both places I found that precautions were being taken to obtain malt free from arsenic. At the Hovis Company a sample of each consignment of malt purchased is now analysed by the firm's chemist, and the finished product is also tested for arsenic. I visited Messrs. Savory and Moore, who also manufacture a malt food, but I was informed by Mr. Eykin that his firm preferred to withhold all information on the ground that their processes are "secret."

Mellins' Food also comes in the category of foods which are essentially dried worts. Rather more than half the ingredients of the wort consist of malt. The malt here is bought from a maltster, who furnishes a guarantee that it is free from arsenic. It had not, however, been analysed for the firm.

In the manufacture of an American product called "Grape Nuts," a dough is made from malt and wheat flour, and then specially cooked and ground.

In another American product, "Horlick's Malted Milk," 25 per cent. of malt is mixed with a similar amount of wheat flour, and added to 50 per cent. of the solid constituents of milk.

There are, no doubt, other foods on the market in which malt is an important ingredient. The use of malt as a food appears to be on the increase, particularly in America.

I have not been able to ascertain the nature of the precautions against arsenic, if any, taken at American maltings supplying malt for this purpose, except that my informants doubted if anthracite was used on account of the price.

In a communication from the Postum Cereal Co., however, I have had a copy of a letter from the American Malting Co., Chicago, in which it is stated that "malt is dried with best anthracite coal absolutely free from smoke," the fumes being drawn through the malt with a fan. The letter further states "We have never heard of any case of arsenical poisoning in this country caused by malt."

From a letter from Mr. Ling, I gather that malt in America is made in the older malt-houses on floors through which the products of combustion pass on to the malt, and in some of the newer kilns in pneumatic drums; also that the fuel is anthracite," "pea coal," or "coke," and special care is taken to add fuel in small quantities at a time in order to reduce the smoke production to a minimum. In many parts of the States the price of anthracite would be prohibitive.

Appendix 24.

FOODS PREPARED FROM MILK.

In foods of this nature an acid is added to precipitate caseine which forms the bulk of the food.

In some foods consisting wholly or partly of milk caseine (*e.g.*, plasmon), the precipitant of the caseine is acetic acid, and it appears unlikely that arsenic would be liable to be introduced in the process of manufacture.

The Plasmon Co. informed me that both the acetic acid and the bicarbonate of soda used by them are guaranteed to be free from arsenic, and are tested at their works in Germany, where the bulk of their products are made. Latterly I hear they are opening a works at Cork.

"Casumen," like plasmon, consists mainly of milk caseine. It has lately become extensively used as an invalid diet, and as an infant food. It is also made up with cocoa, chocolate, and biscuits, and is recommended for mixing with flour for baking. The precipitant employed is sulphuric acid, 1 pint of concentrated acid being employed to precipitate the caseine of 100 gallons of separated milk. It is reckoned that from 550 gallons of milk about 340lbs. of caseine are obtained in this way. Before being dried and made into the finished product, this caseine is washed to free it from all trace of acid, dissolved in a solution of carbonate of soda, and re-precipitated by acetic acid. It is probable that these after-processes would remove a considerable portion of arsenic if any were introduced by means of the sulphuric acid.

The management are aware of the danger of the acid being contaminated with arsenic, and take the following precautions:—The sulphuric acid is bought from two firms, both of which guarantee the acid free from arsenic, and one guarantees that it is made from brimstone. The guarantees bore date March and May, 1901. The sulphuric acids have also been analysed by an independent chemist, and are pronounced by him to be free from arsenic.

VINEGAR.

Vinegar is to be regarded as liable to contamination by arsenic. Professor Campbell Brown and two other public analysts mention this liability in their returns to the Commission; Mr. Low, Public Analyst of Chester, mentions a sample of vinegar in which he found 1-25th grain of arsenic per gallon. I have also been informed by vinegar manufacturers that arsenic in quantities not stated has been found by several chemists in different samples of vinegar. The occurrence of arsenic in vinegar is referred to in Allen's Commercial Organic Analysis, Vol. I., p. 475.

Mention has been made to the Commission of arsenical poisoning, attributable to vinegar among the Artillery at Hillsea three or four years ago. This, however, is believed to have been due to the intentional addition of arsenic, which was present in enormous quantity in the vinegar (Hooper, Q. 7899).

It is possible that arsenic may gain access to vinegar in several ways—from the use of arsenical malt or sour beer; of arsenical sulphuric acid, used to "convert" raw grain for vinegar making; possibly also from use of arsenical glucose or caramel; of arsenical acetic acid; or from the direct addition of arsenical sulphuric acid. Taking these seriatim:—

Malt.—The proportion of malt to total materials used in making "malt vinegar" varies. I saw two manufacturers of "malt vinegar," for instance, who used practically all malt, while another used no more than 1-5th malt.

As regards the total amount of materials relative to the vinegar produced, I was informed by Messrs. Pott and Norbury, who are large vinegar makers, that a usual quantity would be 336lbs. of material to produce eight barrels (288 gallons) of best vinegar. After eight barrels of wort have been drawn off to be fermented into best vinegar, the residue in the mash tun is used along with fresh material for a further mash, producing, when fermented, a vinegar of less strength.

I found that since the Manchester epidemic, in four instances, the malt was being purchased with a guarantee from the maltster of its freedom from arsenic. By three of these manufacturers samples of malt were occasionally sent to be tested for arsenic, or were tested by the firms' chemist. At Messrs. Beaufoy's samples of malt are systematically tested both before and after purchase: malts here having been rejected which, by the Marsh test, showed more than about 1-50th gr. of arsenic per lb.

On the other hand, four other manufacturers of malt vinegar at the date of my inquiry were not requiring guarantees as regards malt, or causing it to be tested for arsenic. One of these stated that so little malt is used in his malt vinegar that such a precaution is unnecessary.

Three of the vinegar brewers whom I visited made their own malt; the first dried his malt with anthracite, and did not test for arsenic; the second used a special process for making malt suitable for vinegar, which does not appear to occasion risk from arsenic; the third used a mixture of anthracite and gas coke, and did not test his malt for arsenic.

Sour Beer.—I have met with only one vinegar brewery in which sour beer is employed, although I understand it is frequently used. At the brewery in question about 1-10th of the total output of vinegar is derived from sour beer. Here the beer was being tested both in sample and during delivery, and I gathered that sour beer showing more than 1-50th of a grain of arsenic per gallon would be reported against by the works chemist, but that none had been found to contain this quantity.

Raw Grain "Converted" by Mineral Acid.—Various other grains besides malt are used in vinegar-making, such as barley, oats, maize and rice in proportion varying, for example, from 1-5th malt to 4-5th of other grain, to 2-5th malt to 3-5th other grain.

These grains are usually mashed without preliminary treatment. At certain works, however, it is the custom to convert the grain (rice or maize grits) into glucose by means of sulphuric acid and steam pressure in converters, and subsequent neutralisation with lime and filtration. It is stated that the process of conversion is not carried so far as is the case in brewers' glucose.

According to data supplied to me by two firms, A and B, who use converted grain, sulphuric acid may be employed in the conversion process to the extent of 3 per cent. of the grain used. One lb. of converted raw grain would go to the gallon of finished vinegar, ·03lb. of sulphuric acid being employed in the production of each gallon of vinegar.

An arsenical acid such as Nicholson's, containing 1·5 per cent. of arsenic, in this case might introduce 3·15 grains of arsenic to the gallon of vinegar.

At the works of firm A, since the Manchester epidemic, sulphuric acid has been purchased with a guarantee of freedom from arsenic, and each consignment has been tested by the firm's chemist, who uses a Gutzeit test. At Messrs. B's the acid used is purchased as "Best Brimstone Acid," and is now regularly tested by their own chemist at their works, who uses a preliminary Marsh test, and subsequently applies a more delicate Marsh-Berzelius test to specimens which have passed the preliminary test. He informed me that he had always found the amounts demonstrated by the Marsh-Berzelius test sufficiently small to be neglected.

Molasses, Glucose, and Caramel.—Glucose appears to be seldom used in the manufacture of vinegar. I heard of its use at one works only, and there it had been abandoned for some time. Caramel is largely used in colouring certain classes of vinegar, but in quite small quantities. It was usually understood by the manufacturer to be made from pure cane sugar; three vinegar brewers whom I visited had caused samples to be analysed for arsenic after the epidemic of 1900, but with negative results.

Molasses may be used to make vinegar, and I note in this connection that one firm of vinegar makers informed me that recently they had found arsenic in their vinegar (quantity not stated), which had been traced back to the molasses used.

Acetic Acid.—A certain class of vinegar consists of dilute acetic acid coloured with caramel, and flavoured with essences, and sold as "vinegar" or "wood vinegar." Much imported vinegar is of this nature. Acetic acid is sometimes added to ordinary vinegar to fortify it. As indicated in Section I., however, the liability of acetic acid to contain arsenic appears small.

Direct addition of Sulphuric Acid to Vinegar is, or was, considered a permissible practice. In "Allen's Commercial Organic Analysis" (3rd Ed., Vol. 1, page 472), it is stated that the amount of one gallon of acid to 1,000 gallons of vinegar (or ·185 per cent. by weight of sulphuric acid) "was permitted by an excise regulation."

I have not met with any vinegar brewery at which free sulphuric acid was added, and I was everywhere informed that the practice is not now at all common.

An arsenical acid such as Nicholson's, containing 1·5

per cent. of arsenic, if added in the proportions above given, as considered "permissible," would contribute 1·9 grain of arsenic to the gallon of vinegar.

Distilled Vinegar.—A certain class of vinegar is distilled before sale in steam jacketted stills. If arsenic were present in the original vinegar it is claimed that none would come over at the temperature of distillation.

Tests applied to Finished Vinegar by the Manufacturer.—As above indicated, certain of the manufacturers visited have adopted since the Manchester epidemic a more or less thorough system of testing their malt and sulphuric acid (if used) for arsenic, and as a rule these manufacturers also from time to time look for arsenic in their finished product. Several other manufacturers, however, at the dates of my visit, had taken no precaution as regards either ingredients or finished product. At the latter manufactories the vinegar was in each instance made from malt, and a proportion of other ingredients, but no sulphuric acid was employed. One large firm of vinegar brewers inform me that since my visit they have undertaken systematic examination of ingredients and product for arsenic.

FOODS IN WHICH COLOURING MATTERS ARE USED.

I have made inquiries as to a few food substances in which colouring matters, mineral or other, such as those referred to in Section I., are employed, with the object of ascertaining what degree of contamination of these foods by arsenic might arise, assuming an exceptionally arsenical pigment were used; and, further, to ascertain what, if any, precautions against arsenic were taken by manufacturers using these pigments or by the manufacturers of the pigments themselves.

Upon the whole it would seem that the quantity of colouring matter which would enter into a pound of a given substance is relatively small, so that a large amount of arsenic in the pigment would involve the introduction of a comparatively minute quantity of arsenic into the finished product.*

For example, as regards materials in which *mineral colouring matters*, such as oxide of iron or Armenian bole, are used. From a report of the Departmental Committee on Preservatives and Colouring Matters in Food, it appears that these substances are used, *inter alia*, in the preparation of anchovy sauce, paste and essence; bloater and shrimp paste; cocoa; certain sweets, particularly burnt almonds; sausages and potted meats.

Assuming for convenience 1 grain of arsenic per lb. in the mineral pigment* (approximately the amount found by Dr. McGowan in a sample of Armenian bole obtained at a London stores), the following calculations may be made:—

Anchovy Sauce.—Proportion of Armenian bole (London stores), 10 per cent.; (provision manufacturer), about 5½ per cent. Taking the larger quantity, this would mean 1-10th grain of arsenic per lb. of sauce.

Sweets.—Proportion of ferruginous earth, 56 grains to the lb. (Cassal, Departmental Committee, 3847): this would mean 1-125th grain of arsenic per lb. of sweets. Proportion of oxide of iron 35 grains per lb. of burnt almonds (Fisher, Departmental Committee, Q. 4780). this would mean 1-200 grain of arsenic per lb. of sweets.

Sausages and Potted Meats.—The quantity of Armenian bole or other pigments used in these substances is determined by personal preference. The large number of recipes for sausages and potted meats in "Douglas Encyclopædia on Hog Products" seldom mention the quantities of colouring matters recommended, and there can be no doubt that they are often used in an entirely haphazard way.

Taking the largest proportion of any colouring matter which is mentioned in the above encyclopædia, namely, 2½ozs. to 15lbs. of "sausage meat," this would mean 1-96th grain of arsenic per lb. of sausage, on the basis of 1 grain of arsenic per lb. of mineral colour.

At the same time I may note that it is possible that a larger quantity of bole Armenia may at times be added; that it is possible that the pigment in question may occasionally contain more arsenic than the sample casually obtained from the stores, and that the distribution of the colour in the sausage may not be uniform.

As regards materials in which the innumerable varieties of "*coal tar colours*" are used, such as jam, sweets, table jellies, egg and cake powders, coloured syrups and temperance drinks made from them, sausages, potted meats and hams, it is well perhaps to make special references to those food substances in which the colouring matter may be a magenta dye, in view of the large amount of arsenic which has been found in certain magentas (Section I.). Assuming one of the highest quantities reported in magenta, 6 per cent., then the following amounts might be contributed to:— Appendix 24.

Jam.—Mr. Boseley (Departmental Committee, Q. 1063) states that at Messrs. Keiller's magenta in red jam would not exceed 1 part in 75,000; this would mean ·0057 grain (approximately 1-180th grain) of arsenic per lb. of jam.

Sweets.—According to the same witness the largest proportion of colouring matter in sweets is (in certain lozenges) 1 part in 2,300. This would mean ·18 grain (nearly 1-5th) arsenic to a lb. of such sweets.

Sausages and Hams.—Magenta colours appear to be used in these substances, but I have not been able to ascertain the proportions. They are said to be mainly used to colour the outside skins, but they are also used to colour the sausage meat.†

I am unable to make corresponding calculations with regard to "coal tar" colour other than magenta, as I have no knowledge of the exact quantities of arsenic which may be found in them; it may, I think, be safely assumed that none are likely to approach the exceptional amount above taken in the case of magenta. Evidence as to the extremely minute quantities of coal tar colours used in foods was given by witnesses to the Departmental Committee. (*See, e.g., Appendix VIII. of that Committee's report in Tables P, Q, and R.*)

Precautions against Arsenic by Manufacturers Colouring Food Substances.—Manufacturers of food using colouring matters in some instances take precautions with the object of ensuring purity of their colours. These precautions, as taken at jam and confectionery firms which I visited, consist in obtaining a guarantee from the colour manufacturer that his colours are "harmless and suitable for confectionery purposes"; such guarantees are sometimes given on the authority of well-known analysts. I gathered from Mr. Hehner, who acts as consulting chemist to many colour manufacturers, and from Mr. Goodfellow, who is chemist to the Confectioners' Association, that in regard to arsenic the estimate of harmlessness and suitability for food purposes is made with due regard to the small proportions in which these colours are used in foods. Mr. Goodfellow, for example, assured me that I should be surprised to learn how much arsenic he permitted in dry colour submitted to him, adding that he was satisfied that by the time that the dry colours had been diluted for use by the sweet manufacturer, and by the time that this diluted colour had been added to a large bulk of confectionery, the arsenic would not be detectable by the most delicate tests when applied to quantities usually employed for analysis. Mr. Goodfellow promised to send me precise data on this point, but they have not as yet come to hand.

After the Manchester epidemic certain large firms of confectioners required that "freedom from arsenic" of the colours supplied to them should be specificially guaranteed. I gather, however, that the colour manufacturer, for reasons above indicated, prefers that the form of guarantee should be restricted to "harmlessness for confectionery purposes."

One or two firms that I visited took the additional precaution of checking these guarantees by the occasional taking of samples; several, however, including some very large manufacturers, were content with the guarantee alone.

At three large manufactories where Armenian bole is used to colour anchovy preparations, no guarantee of the purity of the colour was required, and the manufacturers had no knowledge of the liability of the substance to contain arsenic.

Similarly with regard to the use of Armenian bole, and, indeed, colouring matters of all kinds, in meat preparations, I have been informed alike by a colour maker, a colour seller, and a colour user, that it is never the practice of the meat trade to require any guarantee of purity of the colours used, or to have the colours analysed. These colours are frequently procured at shops where sundry butchers' requisites are sold. At these shops the colour is obtained from middlemen without guarantee of purity.

* As to later information given to the Commission on arsenic in mineral and coal tar colours, *see* McGowan (Appendix 25) and Hehner (Appendix 27).—H.H.S., July 1903.

† Magenta is used in preparation of catsup and chili sauce.—"Food Journal," July 1902, page 153.

Appendix 24.

I visited an important firm of colour makers, whose practice is to take considerable care to secure that colours for food purposes are, in their chemist's view, practically free from arsenic; those which are reported arsenical being put aside for textile purposes. They stated, however, that in selling colours to middlemen they had often no knowledge of the purposes for which these pigments are required, and naturally they would accept no responsibility if ultimately such colours were rejected as unfit for food purposes. To their knowledge middlemen also obtain colours from other firms than themselves without asking for or receiving a guarantee of purity. This was confirmed by a firm of colour sellers; the colour is ordered from them without specific mention of the use to which it is going to be applied; no guarantee is asked for either by consumer or by the merchant from the maker.

I have referred in Section I. to evidence that *caramel* may occasionally be considerably contaminated by arsenic, and to the fact that its liability to be arsenical does not appear to be so generally recognised as that of glucose. The quantity of caramel used in any given article of food is so small that the amount of arsenic which might in this way be introduced per lb. of a given product would be extremely minute; nevertheless it is worth remembering that this colouring matter is used in a very great number of food substances, and is employed for many purposes in domestic cooking.

FOODS IN WHICH PRESERVATIVES ARE USED.

The chief preservatives in regard of which question of arsenic arises are borax and boric acid, the liability of which to contain arsenic has been dealt with in Section I.

The report of the Departmental Committee on Preservatives and colouring matters in food shows that borax and boric acid, or mixtures of these two substances, are added to milk, cream, butter, sausages, and potted meats; they are also used for dusting over or making pickle for bacon, ham, fish, jam, etc. Solutions may also be injected into the substance of the bacon or ham.

I note from the same report a few instances in which boric acid preservatives have been used in considerable proportions.

Milk.—"Boric acid equivalent to 80 grains of borax per pint." Dr. Wynter Blyth (Q. 3439).

*Milk.**—126 grains boric acid per gallon. Dr. B. Hill (Q. 2334).

Cream.—56 grains boric acid preservative per lb. Otto Hehner (Q. 5584).

Butter.—91 to 93 grains boric acid to the lb. Mr. Jones (Q. 1322).

Butter.—17·4 to 47·6 grains of borax per lb. Dr. Still (Q. 6814).

Butter.—3 per cent. or 210 grains boric acid per lb. Trengouse (Q. 678).

Sausages (German).—Nearly ½ per cent. (35 grains per lb.) reckoned as boric acid. Fisher (Q. 4717).

Sausages, Polonys, etc.—Up to 58·8 grains per lb. of a powder containing 93 per cent. boric preservative, estimated as boric acid recommended by the trader (Government Laboratory Table H, page 60).

It is unnecessary to give instances of the quantity of these preservatives for dusting or pickling, as the amount remaining in the food is necessarily uncertain.

It should be noted that the Committee recommended that the use of preservative in milk should be constituted an offence under the Sale of Food and Drugs Acts, and that as regards cream, butter, and margarine, boron preservatives should be restricted respectively to ·25 per cent. and ·5 per cent. in terms of boric acid. How far these recommendations have led to diminution in the use of boron preservatives in these substances I am unable to indicate; reports of their detection in considerable quantities in milk and butter continue to be reported from time to time.* The Committee did not recommend restrictions in the amount of boron preservatives added to sausages, potted meats, etc. Considerable quantities of such preservatives are from time to time reported, *e.g.*, in July, 1902, a case was reported of potted shrimps containing 41 grains of boric acid to the lb.

Taking a few instances of food containing exceptional amounts of boron preservatives, and assuming in each instance ¼ grain of arsenic to the lb. of preservative (an amount which appears not infrequently to be present in commercial borax), then:—

Milk receiving 80 grains of borax per pint would contain about 1-44th grain of arsenic per gallon; that receiving 126 grains preservative per gallon would contain about 1-222nd grain of arsenic per gallon.

One lb. of cream receiving 56 grains of preservative would contain 1-500th grain of arsenic.

One lb. of butter receiving 210 grains of the preservative would contain 1-133rd grain of arsenic.

One lb. of potted shrimps receiving 95 grains of borates per lb. (see "Times'" report, November 10th, 1901), would contain about 1-300th grain of arsenic per lb.

Professor Delepine (Appendix to Evidence, Table XI), informed the Commission that he found 1-100th grain of arsenic per lb. in potted German shrimps.

It will be noted that in the above calculations, even when instances are taken in which these preservatives are used in exceptionally large quantity, the amounts of arsenic are small. But it must be remembered that they are based upon an amount of arsenic stated to be commonly found in commercial borax, not upon exceptionally arsenical samples.

Preservatives are usually obtained by milkmen, butchers, and sausage-makers, without any guarantee as to their purity.

Bi-sulphite of lime is added as a preservative to beer, cider, lime juice, etc., and is used as a meat preservative. The evidence, however, that bi-sulphite may contain material quantities of arsenic is meagre, and the quantity of this preservative which enters into the finished article is relatively small.

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* On July 3rd, 1902, Ernest White, at Bournemouth, was convicted of selling milk with 112 grains boric preservative per gallon ("Food Journal," July, 1902, page 161), and at Woolwich, on September 17th, 1902, a milk seller was fined in respect of 120 grains boracic acid per gallon of milk (September 18th, 1902).

SECTION III.

Appendix 24.

FOOD SUBSTANCES DRIED BY EXPOSURE TO THE PRODUCTS OF COMBUSTION IN THEIR RELATION TO ARSENIC.

In inquiring under this head, I visited several firms in London, Bristol, Hull, and other parts of Yorkshire. My object was to ascertain what foods, if any, are dried, like malt, by exposure to the fumes of fuel liable to contain arsenic, and to inquire what in each instance was the nature and duration of such exposure.

Smoked Fish and Meat Foods.

The trade term "smoked," applied to articles such as bacon, ham, red and kippered herrings, Finnan haddocks, smoked salmon, smoked sausages, appears to be almost wholly restricted to those which are exposed for longer or shorter periods to the fumes of wood fires.

In all places visited I found that such smoking was being carried out over a smouldering fire of wood shavings, or more commonly sawdust (chiefly oak-dust), in almost closed chambers of varying size.

Dried Fish and Meat Foods.

Bacon, ham, bloaters, etc., may also be what is termed in the trade "dried," and not smoked. In some instances (*e.g.*, some kinds of ham), the food after drying received no further treatment from the curer; in others (*e.g.*, some kinds of red herring), drying is a preliminary to smoking by wood.

As regards these drying processes:—

Ham and *bacon* may be dried without artificial heat, being merely hung up in the air; or the more modern method may be followed, of hanging them in well-ventilated rooms or chambers, specially constructed for the purpose, and warmed by hot water pipes, or by stoves, the fumes of which do not pass through the chamber.

Drying may also be effected by exposure to fumes of gas coke fires. Some firms visited had abandoned this method of drying, and adopted the hot air chamber; others used coke only exceptionally, when it was necessary to dry as many articles as possible in a short time. Some of the larger firms visited, however, dried exclusively over coke. Where this is done the hams may be hung in large chambers—as at one firm visited, where the chamber is a low building about 15ft. square, in which the hams hang about 8ft. above a large open brazier for about 48 hours. Sometimes, as at Bradford, a smaller chamber, like an ordinary smoke-hole, is similarly used. At a large drier's in Yorkshire the hams are hung in tiers in a separated portion of an old barn. The coke was placed in a brazier under the hams, the nearest tier being about 6ft. from the fire. The duration of the drying varied according to the weather from two to four days. Hams thus treated are usually mild-cured American hams, to which the coke is said to impart a suitable flavour. Some of these hams were afterwards smoked over wood. English York hams, at one Yorkshire firm visited, were always dried over coke, and were not subsequently smoked.

Herrings, *red herrings*, and *kippers* appear to be smoked over sawdust fires; it is said that coke is of no use for this purpose.

Bloaters in London and Yarmouth are usually dried over hard wood fires. According to information kindly supplied to me by the Public Health Department of the London County Council, at 46 out of 60 small fish shops in London, where bloaters were made for sale on the premises, wood was chiefly used, and at the large wholesale establishments in London which I visited this was also the case. A few small London shops dry bloaters over gas coke, especially in the winter, and gas coke drying is in general use throughout Yorkshire.

I visited several smoking and drying establishments in Hull and Bradford. The size of the drying chambers and the duration of the drying varied considerably. As a rule, the bloaters hang in tiers, the lowest tier being about 8ft. from the fire. The ventilation of the chamber is regulated by Venetian shutters near the roof. From 6 to 18 hours are the ordinary limits of exposure to gas coke fumes. Occasionally, however, the time is considerably greater. A fish-curer at Bristol informed me that bloaters might be left a week in the coking-room pending their sale, and that if unsold at the end of the week they would be smoked over sawdust and sold as red herrings.

As regards the extent of arsenical contamination to which ham or bloaters thus dried over coke may be considered liable, it is impossible to make any positive statement in the absence of a sufficient number of experiments in which drying has taken place under varying conditions of temperature, length of exposure to the fumes, and the amount of ventilation, in instances where the fuel used is gas coke, known to contain considerable proportions of volatisable arsenic. *Primâ facie*, it would seem unlikely that the degree of contamination possible in the case of these dried foods would approach that to which malt is liable, for the reason that in proportion to bulk the surface exposed to the products of combustion is much less than in the case of malt. Moreover, the arsenic would be deposited on the skin of the ham or bloater, and is therefore not likely to be eaten.

Number of Sample.	Date of Collection.	Nature of Sample.	Origin.	How Smoked or Dried.	How long Smoked or Dried.	Nature of Sample Examined by Dr. McGowan.	Quantity of Arsenic in Grains per lb.	Remarks.
I.	14th June 1901.	Ham - - -	Messrs. Maconochie Bros.	Coke and sawdust.	Coke, 48 hours. Sawdust, 12 hours.	Liquor in which the ham was boiled. Ham skin -	No appreciable amount. ·0025 grain per lb.	Examined 7th Nov. 1901.
II. (a)	7th April 1902.	Bloaters from top tier of coke room.	Mr. H. Moody, Hull.	Coke -	5 hours -	Skin - -	·0016 grain per lb.	Examined when mouldy.
(b)	7th April 1902.	Bloaters from lowest tier of coke room.				Skin - -	·002 grain per lb.	Examined when mouldy and decomposing.
III. (a)	7th April 1902.	Bloaters from top tier of coke room.	Messrs. Tether & Son, Hull.	Coke -	10 hours -	Skin - -	·0047 grain per lb.	Examined when considerably mouldy.
(b)	7th April 1902.	Bloaters from lowest tier of coke room.				Skin - -	·0085 grain per lb.	
IV. (a)	7th April 1902.	Bloaters from top tier of coke room.	Mr. Hodman, of Hull.	Gas coke -	15 hours -	Flesh - -	·0029 grain per lb.	Examined fresh.
						Skin	·0009 grain per lb.	
(b)	7th April 1902.	Bloaters from lowest tier of coke room.				Flesh	·00006 grain per lb.	
						Skin -	·0023 grain per lb.	
V. (a)	8th April 1902.	Bloaters from top tier of coke room.	Messrs. Fletcher, Bradford.	Coke -	18 hours -	Skin - -	·005 grain per lb.	Putrifying; not much mould.
VI. (a)	8th April 1902.	Bloaters from top tier of coke room.	Messrs. Hibbert, Bradford.	Coke -	18 hours -	Skin - -	·007 grain per lb.	Putrifying; not much mould.

Appendix 21.

The above tables show the results of analysis of a few samples of ham and bloaters which were being dried over coke at the time of my visit, or had just been so dried. It will be observed that the quantities of arsenic in the skins is in no case large, the highest (Sample VI. (a)) being 1-140th grain per lb. In the case of the bloaters the small amount of arsenic in the skins appears to bear some relation to the number of hours the fish were exposed to the fumes of the coke.

In the case of the bloaters in which the flesh was examined, the highest quantity of arsenic determined was 1-350th grain per lb. I should add, however, that I have no knowledge of the amount of volatile arsenic in the gas coke used in drying these samples.

It would seem from the evidence which the Commission has received from Mr. Ling and others, that the possibility of arsenical contamination of dried foods would be largely diminished if it were made a practice to add milk of lime to the coke used in drying.

Grilled Foods.

The possibility that meats or other food grilled over an open fire, and particularly over coke, may become contaminated with arsenic, has been mentioned to the Commission; but, looking to the short time that the meat is exposed to the fumes, and to the free access of air during the cooking, it seems hardly conceivable that material contamination can take place. The ordinary grill of a restaurant where coke is used is so constructed that the smoke and fumes are drawn directly backwards into the chimney and so avoid the meat. I have been in communication with Mr. Fairley respecting the possibility of coal gas introducing arsenic into food cooked in gas stoves. Mr. Fairley is making some experiments to ascertain the fate of any arsenic which does not remain behind in the coke in the manufacture of the coal gas, and has kindly undertaken to inform the Commission of the results obtained.*.

Chicory.

Chicory is grown and dried principally in Belgium and the North of France. According to a publication on Chicory† lent me by Messrs. Taylor and Churchill, chicory importers, the process consists in first washing the roots, which are then cut up into pieces, about 1½in. long and 1 square inch in section, and dried in special kilns. These kilns appear sometimes to have more than one drying floor, and the products of combustion pass through the cut-up roots, being admitted through apertures in each floor.

The fuel (in more modern plans of drying) is said to be coke, although in some works, where old systems of drying are in vogue, "tourbe" (? peat) is used.

The drying process appears usually to take about 24 hours for ordinary chicory. I have no knowledge as to whether the coke used is gas coke or oven coke. I may quote, however, the following passage from M. Storme's book as showing that the noxious character of the coke fumes in the kiln is well recognised by those engaged in the trade:—

> "Il faudrait avant tout pouvoir supprimer les ouvriers qui retournent les cossettes nuit et jour. On comprend que dans une atmosphere saturée de vapeur à une température moyenne de 60° C., et remplie des gaz suffoquants qui proviennent de la combustion de coke, le travail ne soit ni agréable ni hygiénique. Aussi se paie-t-il 3 fr. par jour ce qui est beaucoup dans les provinces ou se cultive la chicorée."

According to the same author, it requires 60 kg. of coke to dry from 4,000 to 5,000 kg. of roots, and again it requires 350 to 425 kg. of green roots to produce 100 kg. of dried roots.

In addition to the drying described above, the chicory for the English market receives a further and special drying in kilns in consequence of the duty, namely, 13s. 3d. per cwt., which is payable on the weight, the object of the special kilning being to dry as much as possible short of burning.

In England the chicory thus dried is roasted (either before or after being ground) in drums, or else in open pans over coke fires, the fumes from which do not reach the chicory.

Mr. W. Thomson, of Manchester, has found arsenic in two casual samples of chicory, about 1-100th grain of arsenic per lb. in each sample. No other of the public analysts have mentioned in their returns to the Commission any analyses for arsenic of chicory or coffee and chicory mixtures. The liability of chicory to contain arsenic has been mentioned by Mr. Thomson only.

It would seem that the method of drying chicory over coke involves a risk of arsenical contamination comparable to that in the case of malt, and by analogy it appears that the maximum extent of contamination by arsenic which may occur could be determined only by examination of a large number of samples representing various methods of kilning in which different fuels were used. The few samples which I obtained, without knowledge of their origin, are quite insufficient to determine this question. Dr. McGowan has tested six samples, with results as follows:—

No. 5: Chicory root as dried and imported ready for roasting, none by Reinsch test.

No. 20A: Raw chicory as bought from Holland ready for roasting, 1-730th grain of arsenic per lb.

No. 21B: Chicory dried and ground ready for roasting, 1-730th grain of arsenic per lb.

No. 22C: Chicory after roasting in open pans, 1-730th grain of arsenic per lb.

No. 22D: Chicory ground after roasting in cylinders, 1-200th grain of arsenic per lb.

No. 5 came from a London chicory importer; Nos. 22 to 23, all from another importer at Bristol.

The last four samples were not selected as coming from the same kiln, and therefore no inference can be drawn as to the effect of the roasting at the works upon the arsenic they contained.

"Chicory and coffee mixtures" are often sold which contain over 50 per cent. of chicory. If 1lb. of such mixture were used to a gallon of coffee, then for the coffee to contain 1-100th grain of arsenic derived from the chicory it would be necessary for the chicory to contain 1-50th grain of arsenic to the lb.

Coffee.

Quite recently the practice of roasting coffee in a drum outside the products of combustion has been superseded at several factories by a more rapid method of roasting in which the beans are exposed to the fumes of gas or gas coke.

Where gas is used, a large Bunsen flame is directed into the middle of the drum in which the beans are kept in rapid motion by the revolutions of the drum; the roasting is completed in from 10 to 20 minutes. Where gas coke is used, the coffee is placed in a drum of open wire mesh rapidly revolving over a glowing coke fire. The drum is just clear of the fire. Exposure to the coke fumes lasts from 10 to 20 minutes, according to the quality of the coffee required.

A sample taken immediately after roasting in this way over coke was taken by me on September 13th, 1902, and has been sent to Dr. McGowan for analysis. This sample contained 1-730th grain of arsenic per lb.

Dried Lemon Peel.

The peel of lemons and oranges may be dried over coke. I visited one manufacturer whose entire business consists of drying lemon peel in this way. This peel, however, is never used for candied peel. Its principal use is to make medicinal tinctures. The peel, cut into thin strips, is hung upon strings in a small room for three days to dry in the air; then a brazier of gas coke is brought in, the doors and windows tightly closed, and the peel exposed to the coke fumes for three hours.

I may note here that the manager of Messrs. Burroughs and Wellcome, manufacturing druggists, who test a large number of products systematically for arsenic, informed me that occasionally traces of arsenic had been found in certain spirituous extracts, the origin of which had not been discovered at the date of my visit. It is possible that the use of coke in drying materials for medicinal purposes may be found to afford an explanation.

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* Now *see* Addendum B to this report, below.—H.H.S., July 1903.

† "Culture et Fabrication de la Chicorée à Café," par J. Storme. Louvain, 1896.

SECTION IV. Appendix 24.

MISCELLANEOUS; FLESH OF FOWLS RECEIVING ARSENIC; ARSENICAL INSECTICIDES; ARSENIC IN ENAMEL OF COOKING UTENSILS, ETC.

Arsenical Insecticides in Relation to the Possible Contamination of Fruit.

The principal arsenical insecticides are Paris Green, Scheele's Green, London Purple, and Arsenate of Lead. They are used to destroy the larvæ of the "Winter Moth," the "Great Winter Moth," the "Canker Worm," the "Lackey Moth," the "Brown Tail Moth," the "Gooseberry Saw Fly," the "Magpie Moth," the "Codlin Moth," the "Asparagus Beetle," the "Cherry Saw Fly," etc. The following are fruit trees and plants liable to be treated with these insecticides: Apples, pears, cherries, gooseberries, cabbages, and asparagus. The use of arsenical substances as paints to the bark of trees need not here be considered. In the case of fruit, these insecticides are used in the form of spray of varying strength, in the case of Paris green up to 1lb. to 100 gallons of water, in the case of arsenate of lead, 15lbs. to 100 gallons. They are applied at different periods of the growth of the fruit, from the time of the bursting of the fruit bud onwards. In the case of the cabbage, it is recommended in the "Farmers' Bulletin" of the United States Department of Agriculture, No. 127, that a powder consisting of 1oz. of Paris green to 6lbs. of flour should be dusted on the cabbages. I have not heard, however, of this practice in England.

In the case of asparagus, a solution of Paris green may be used to apply to the asparagus plant to destroy the asparagus beetle. It is recommended, however, that this should not be used until all the crop has been cut. (Board of Agriculture leaflet, No. 47.) It is similarly stated in other leaflets prepared by the Board of Agriculture that it may be dangerous to use arsenical preparations shortly before the fruit is to be picked, and I should imagine that most fruit-growers would not allow their use in these circumstances. From my knowledge of the indiscriminate way in which uneducated gardeners may use insecticides, however, I should not be surprised if through lack of supervision arsenical insecticides are occasionally applied at too late a date. As an instance of what might happen in such a case, the following experiment may be of interest. On July 16th, 1901, I watered a gooseberry tree, the fruit of which was then half-grown, with a mixture of Paris green and soft soap, the strength being 1½ drachms of Paris green to 1 gallon of soap and water. This strength was recommended to me some years ago by a friend of great experience in gardening as suitable for destroying the larvæ of the magpie moth. Rain fell heavily on the 22nd and 23rd, and was falling when the first sample (half-ripe gooseberries) was picked on the 24th. These berries showed, according to Dr. McGowan, 1-20th grain of arsenic per lb. On July 27th and 28th very heavy rain fell, on the 30th slight rain, on August 10th slight rain, on the 12th slight rain, on the 13th the remainder of the berries were sent to Dr. McGowan. They showed 1-60th grain of arsenic per lb., showing that one month after spraying and after heavy rain, a considerable proportion of arsenic still remained on the fruit. With reference to these experiments I should note that the object of the watering is to destroy the magpie moth larvæ on the leaves, but it is, as I found, practically impossible to prevent the solution from reaching the fruit. It is probable, however, that ordinarily the larvæ would make their appearance before the fruit had attained the size which it had at the time when I watered this bush with the Paris green, as usually in my experience these larvæ appear towards the middle or the end of June. If a gardener had occasion to apply Paris green when the fruit was nearly ready to pick, it may be assumed that he would pick the fruit before applying the insecticide.

Paris green is also stated to be syringed over gooseberry bushes to destroy the gooseberry saw fly. This fly appears (Board of Agriculture leaflet No. 12) early or late in April, according to the nature of the season, when the fruit is only beginning to set.

In his evidence to the Commission, Dr. Stevenson (Q. 2341) alluded to the possibility of dried apples containing small quantities of arsenic, which he attributed to the use of arsenical sprays during the growth of the apple, the arsenic adhering to the skins. The "Farmers' Bulletin" of the United States Department of the Board of Agriculture above referred to, deals with the use of arsenical insecticides, particularly for apples, and states on p. 13 that the poison disappears from the fruit completely within 20 to 25 days, and that if the plants were eaten immediately, an impossible quantity would have to be consumed before a poisonous dose could be taken.

Use of Arsenic for Fattening Poultry.

It has been stated that arsenic is administered to poultry for the purpose of fattening them. A writer in the "Daily Mail" of March 4th, 1901, stated that it was the practice in forced feeding of poultry to administer arsenic shortly before the birds were killed, so as to enable them to assimilate more food and put on extra fat. The secretary of the Commission was put into communication with the writer of the article by the editor of the "Daily Mail." This gentleman was not a poultry breeder, but he said that the statements in his article were the result of information obtained at some poultry farms in one of the home counties. The use of arsenic had been mentioned to him casually by a man who claimed to know what was done at a particular farm; the writer of the article knew no details regarding this practice.

Mr. Tegetmeier, of the "Field," who is an authority on poultry, was positive that arsenic was not used for this purpose, and told me that in his opinion arsenic would cause loss of appetite and irritation of the fowl's crop.

From my inquiries among a few poultry fatteners and purveyors of poultry foods, I am led to infer that something more than meal and fat is used for feeding purposes, but naturally it is extremely difficult to find out what each man uses, as directly arsenic was hinted at all information ceased.

The experiments of Professor Delépine on rats indicate that so long as a growing rat is receiving abundance of food, arsenic will tend to quicken its normal increase of weight, and the well known use of arsenic to improve horses and cattle suggests that it is not improbable that a poultry fattener would find a distinct advantage in its use.

In order to ascertain whether poultry are as intolerant of arsenic as Mr. Tegetmeier asserted, I made a few experiments with my own fowls. Not caring to use a forcing apparatus, I administered the arsenic with the soft food given daily in the morning, and no other food was given to those birds until the whole of the arsenical food had been consumed. I fed four chickens this way, and two others I fed on a similar diet but without arsenic; each bird had a separate run in the same field.

Six chickens taken in the middle of July; all of one brood, ordinary cross-bred birds. These weighed:—

Nos. 1 and 2—14 ozs.

Nos. 3 and 4—16 ozs.

Nos. 5 and 6—17 ozs.

Birds put in their separate runs and kept under exactly similar conditions until they were fit for fattening on August 12th.

From August 12th onwards food in each instance given daily as follows:—

First feed: Small quantity of mixed grain early in the morning.

Second feed: Measured and identical quantity of soft food, sharps, and house scraps at 10 a.m.

Third feed: Corn in the afternoon.

Birds 1 and 2 throughout had no arsenic.

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Birds 3, 4, 5, and 6 received with their soft food measured quantities of solution of arsenic of known strength prepared from B.P. Liquor Arsenicalis, the strength of which was checked by Dr. McGowan and found to be correct. This solution of arsenic was intimately mixed with the soft food.

Birds 3 and 4 received daily doses equal to 2 minims of Fowler's solution (1-55th grain of arsenious oxide) per day, from August 12th to December 2nd, a period of 16 weeks; total arsenic in each instance 2 and one-third grains.

Birds 5 and 6 received daily doses equal to 2 minims of Fowler's solution (1-55th grain of arsenious oxide) from August 12th to August 25th (12 days); the dose on August 25th being increased to 4 minims of Fowler's solution (2-55th grain of arsenious oxide) per day.

Bird No. 5 continued this double dose till October 28th, when it was killed. Total arsenic administered 2 and three-fifth grains.

Bird No. 6 continued this double dose till November 25th, when it was killed. Total arsenic administered 3 and three-fifth grains.

During the above periods practically all the soft food given was consumed by the birds each day, and nearly all the arsenic administered must have been taken.

Appearance and Condition of Birds.—All six birds grew and kept healthy; those taking arsenic showed an unusual gloss and brilliancy of plumage which was not shown in the control birds. This shows that birds may thrive, notwithstanding the administration of arsenic in considerable doses, for a long period. On 2nd December, Birds 3 and 4, however, had their dose of arsenic increased to 4 minims, on the 3rd to 5, and on the 6th to 6. The result of these larger doses was that both the birds refused their food.

Gain in Weight.—I append a table showing the results of weekly weighings. In each instance it is impossible to draw any very definite inference as to the effect of arsenic on the rate of increase, particularly as the two control birds turned out to be pullets, while of the four birds receiving arsenic three were cockerels and one was a pullet. Upon the whole, however, there are some indications that the arsenic produced at first a temporary gain in weight as compared with the controls, but that after the administration had been continued for eight or nine weeks the same rate of increase was not maintained. The weight of Bird No. 4, for example, having steadily increased up to October 14th, remained almost stationary during the following 10 weeks.

Arsenic in Flesh and Liver of Birds Nos. 5 and 6.—Bird 5 killed October 28th. Dr. McGowan found in flesh (white and dark), 1-600th grain of arsenic per lb.; in liver and heart together, 1-2,000th grain (1-200th grain per lb.); in gizzard, about 1-2,000th grain.

Bird 6 killed December 2nd: Liver, 1-2,000th grain arsenic in the whole (=1-200th grain per lb.); flesh not examined. The coarse feathers of this bird were separated and analysed, with results as follows: Coarse feathers, 1-25th grain in weight taken, equivalent to 2-5th grain arsenic per lb.; medium and fine feathers, 1-60th grain in weight taken, equivalent to 1-5th grain arsenic per lb.

The above results suggest that the administration of a relatively considerable quantity of arsenic to the fowl under such conditions as I have described does not entail a contamination of flesh, liver, or gizzard to any appreciable extent. On the other hand, the illustration which they afford of the elimination of arsenic by the feathers is instructive as showing the affinity of the keratine tissue for arsenic.

Possible Contamination of Food by Means of Enamelled Cooking Utensils.

In view of a statement made to me by Mr. Cochrane, a retired ironmonger, that he had had personal experience of illness caused by the use of new enamelled hardware pans, and the use of arsenic as a constituent in white enamel hardware goods being well known, I have procured samples of different makers of such goods for investigation.

The question I wished to investigate was whether arsenic is still used in making the enamel that lines cooking utensils, and I asked Mr. Cochrane to collect for me a number of samples from different makers, which have been sent to Dr. McGowan for examination, the result of which is not yet to hand. That some makers know the risk of using arsenic in the manufacture of their enamel goods is shown by many of them advertising on their price lists that their goods contain "No arsenic."

Mr. Cochrane stated that when in business he supplied a hotel in London with enamel stewpans, in an emergency, instead of copper pans, and everyone who partook of food cooked in these pans became ill. He also quoted two other cases of illness in his own family which he attributed to the use of new enamel stewpans, his theory being that when a new pan is used the act of washing with carbonate of soda and subsequent cooking dissolves the arsenic in the enamel, if present. Upon this point I have asked Dr. McGowan to make some experiments when examining the enamels in question.*

Table showing Influence of Arsenic on Weights of Experimental Fowls.

Number of Bird.	Daily Dose of Arsenic during Period of Weekly Weighings.	Total Arsenic taken during Period of Weekly Weighings.	Weight when Bought in Middle of July 1901.	Weight when Weekly Weighings began 12 Aug. 1901.	Period of Weekly Weighings.—Gain or Loss of Weight in Ounces each Week.																Weight when Killed at end of Experiment.
					19 Aug.	26 Aug.	2 Sept.	9 Sept.	16 Sept.	23 Sept.	30 Sept.	7 Oct.	14 Oct.	21 Oct.	28 Oct.	4 Nov.	11 Nov.	18 Nov.	25 Nov.	2 Dec.	9 Dec.	16 Dec.	
			ozs.	ozs.																			ozs.
1. (Pullet)	No arsenic throughout		14	26	+1	+1	+3	+4	+3	+3	+5	+3	+ 8	+1	+4	+1	+4	+3	+2	+9	-6	-4	70
2. (Pullet)	No arsenic throughout		14	26	+4	+3	+2	+5	+3	+4	+4	+1	+ 8	+2	+2	+0	+2	+0	-3	+3	+1	+1	68
3. (Cockerel)	29 Aug. to 1 Dec. ⅄ grain 2 Dec. to 16 Dec. ⅄ grain	2⅘ grains in 108 days	16	22	+4	+8	+4	+7	+4	+5	+7	+6	+13	+4	+1	+6	+0	+4	+9	+2	+4	+6	106
4. (Pullet)	29 Aug. to 1 Dec. ⅄ grain 2 Dec. to 16 Dec. ⅄ grain	2⅘ grains in 108 days	16	38	+4	+7	+2	+3	+3	+2	+0	+3	+ 8	+0	+1	+0	+1	-1	+1	+0	+4	+0	
5. (Cockerel)	12 Aug. to 24 Aug. ⅄ grain 24 Aug. to 28 Oct. ⅄ grain	2⅗ grains in 78 days	17	38	+3	+5	+2	+5	+3	+3	+5	+7	+11	+1	+2	Killed	-	-	-	-	-	-	86
6. (Cockerel)	12 Aug. to 24 Aug. ⅄ grain 24 Aug. to 25 Nov. ⅄ grain	3⅖ grains in 106 days	17	40	+7	-3	+6	+2	+3	+1	+2	+7	+13	+2	+3	+7	+1	+2	+4	Killed	-		94

* As to chemical examination of enamelled hardware from various sources, *see* Dr. McGowan's Report in separate Appendix, No. 29

SECTION V. Appendix 24.

SUMMARY.

I may briefly summarise certain of the principal points dealt with in this report as follows:—

(1) *Glucose* is an important ingredient of numerous articles of food, particularly of table syrups, jams, marmalade, confectionery, and biscuits; also of sundry beverages, particularly brewed ginger beer and certain kinds of wine.

In most of these foods and drinks the proportion of glucose used may be considerable. Arsenical contamination of the glucose on the Bostock scale would involve serious contamination of the finished products. Use in these substances of glucose containing as much arsenic as has in exceptional instances been found in samples on the market in 1901-2, and not coming from Bostock's (*e.g.*, 1-25th to 1-10th grain of arsenic per lb.) would also in most instances involve a material degree of contamination of the finished product by arsenic.

Nearly all the glucose used in these substances is of foreign, usually American, origin.

Food manufacturers using glucose differ very much in their method of taking precautions to secure that it is satisfactory as regards arsenic. At works visited by me analytical control of greater or less stringency had been adopted since 1900 by certain firms; others, the majority, were content with guarantees given by glucose manufacturer, middleman or agent; others again had required no guarantee and had not tested their glucose for arsenic.

(2) In instances where I heard of the use of *invert sugar* by cider makers or by manufacturers of brewed "temperance beverages," it was either obtained from brewing sugar manufacturers taking precautions to exclude arsenic from their invert sugar, or it was prepared by the cider maker without the use of sulphuric or hydrochloric acid.

(3) The use of sulphuric acid in the preparation of "*golden syrup*" and *treacle* involves risk of serious contamination by arsenic if the precautions taken to secure a satisfactory acid are insufficient. I visited the works of two large sugar refiners who make syrups of this class. Each had adopted a stringent system of analysis and control in this respect.

(4) The use of sulphuric acid to convert raw grain in *vinegar making* involves risk of serious contamination of the vinegar by arsenic in the absence of sufficient precautions. Care in this respect was taken by the two firms visited which manufactured vinegar in this way.

(5) Besides the foods above mentioned are a few others, in the preparation of which sulphuric or hydrochloric acid may be used. In the case of certain *meat extracts*, "peptones," the amount of hydrochloric acid employed is relatively minute. Direct addition of sulphuric acid to *vinegar* and *pickles* appears to be seldom practised. If a strongly arsenical acid were employed these substances might become contaminated by arsenic to a material degree. The information thus far obtained does not suggest that sophistication of *spirits* by mineral acids, if still practised, is common.

(6) Commercial *phosphoric* acid and commercial *phosphates*, such as are used in sugar refining and in baking powders, are liable to contain arsenic, but the quantity of arsenic which could be introduced in this way into finished products is in most instances small.

(7) *Tartaric and citric acids*, largely used for food purposes, particularly as ingredients of lemonade powders and the like, are liable to contain arsenic. The steps habitually taken by manufacturers of these acids in this country to secure freedom from lead also tend to make serious contamination by arsenic unlikely, and it is the custom of food manufacturers to demand that these acids should be satisfactory in regard of lead.

(8) The use of exceptionally large quantities of *boron preservatives* in articles such as milk, cream, and butter may involve the introduction of material quantities of arsenic into these substances.

(9) *Glycerine* has occasionally been found to contain large amounts of arsenic (*e.g.*, 2 to 4 grains per lb.); quantities of arsenic less than 1-15th grain arsenic per lb., if present, might not be detected by the tests prescribed for glycerine in the British Pharmacopœia. Glycerine may be used in cakes to the amount of 4 per cent., and also an important ingredient of certain sweets and meat extracts.

Certain food manufacturers visited employed glycerine stated to conform to pharmacopœial tests; they had not, however, caused the glycerine supplied to be analysed for arsenic, and they did not recognise that arsenical glycerine might cause objectionable contamination of their products.

(10) Arsenic may be present in sundry "coal tar" *colouring matters* used in food. In the case of confectionery, it appears usual for the confectioner to obtain colours with a guarantee from a responsible analyst that they are harmless for confectionery purposes, such guarantee being given with due regard to the quantity of the colour likely to enter into the finished product. Samples of Bole Armenia and other *mineral pigments* have been found to contain over 0·8 grain of arsenic to the lb.; these pigments are used in sausages, anchovy preparations, and the like, without any steps being taken to secure their wholesomeness.

(11) In one instance *sheep wool grease* sold as "cocoa butter," and employed in sugar refining, contained about 1-6th grain arsenic per lb., probably derived from arsenical sheep dip.

(12) Samples of brown "*Demerara*" *sugar* coming from the West Indies in certain instances have been found to contain small amounts of arsenic, 1-300th to 1-50th grain per lb.

(13) The British manufacturers of *maltine and malt preparations* visited were in each instance taking precautions to secure that the malt used was satisfactory as regards arsenic. Foods manufactured in America which consist largely of malt are coming into extensive use in this country. In the absence of more exact information as to American systems of maltings, and of analyses on a comprehensive scale, I am unable to indicate whether these foods are subject to any material risk of arsenical contamination.

(14) A food preparation consisting mainly of brewers' *yeast*, "Carnos," has been found to contain 1-6th grain of arsenic per lb., notwithstanding the precautions against arsenic adopted in its manufacture.

(15) *Chicory* may be dried by exposure of the roots to fumes of coke for several days. None of the few samples examined for arsenic has shown more than 1-100th grain of arsenic per lb. of chicory, but examination of a sufficient number of representative samples would be necessary before a satisfactory estimate of the degree of liability of chicory to contain arsenic can be obtained.

(16) *Hams, bloaters, coffee, lemon peel, etc.*, may be dried by exposure to the fumes of coke, but the degree to which these substances are likely to become contaminated by arsenic in this way is slight.

(17) Considerable daily doses of arsenic may be administered to *fowls* for several weeks or months without causing their flesh or livers to contain more than extremely minute quantities of arsenic.

It will be seen that the food and drink substances referred to in this report vary within wide limits in respect of their liability to contain arsenic. Of foods which are subject to risk of serious contamination the principal are those in which glucose is used, or which, like glucose, are prepared by the use of a relatively large quantity of sulphuric or hydrochloric acid. There can be no question of the necessity that stringent precautions as regards arsenic should be taken by manufacturers of foods of this class, and by persons using them in the preparation of other foods. In the case of certain other foods dealt with, the liability to contamination

Appendix 24.

by arsenic is not so great, but it seems nevertheless important that precautions against arsenic should be taken by those manufacturing them; for example, foods made with glycerine; foods consisting largely of yeast; chicory; or West India sugars. In a third class of foods dealt with in the report, it may be urged that the liability to arsenical contamination, in the absence of all precaution, is so slight that there is no occasion at all for the question of arsenic to be considered by the manufacturer; or again, in the case of particular substances (Anchovy sauce, for example), it may be claimed that precaution is unnecessary on account of the small quantities in which they are taken by the individual. But in the majority of cases it would seem a matter of little difficulty for the manufacturer of the substances here in question to secure that none of his ingredients, even if used in small amount, contains any noteworthy proportion of arsenic. A sugar refiner, or mineral water maker, for example, might use phosphoric acid or phosphates containing relatively large amounts of arsenic without contaminating his finished product to a degree which could be considered objectionable. But as he can obtain these substances practically free from arsenic with little additional trouble or cost, it would seem more satisfactory that he should do so, and thus secure that his finished product was free from arsenic, in the sense that no arsenic would be detectable, by Marsh-Berzelius test, in quantities of his product such as are usually taken for arsenic analysis. And if the small proportion of a given ingredient renders its content of arsenic of less moment to the consumer, it also renders insignificant the extra cost of arsenic-free material.

In connection with these questions it is right that I should record the fact that several manufacturers asked me to represent to the Commission their desire that the quantities of arsenic to be considered inadmissible in particular ingredients of foods should be authoritatively laid down—to adopt the usual phrase, "in order to give them something to go upon." Representations in this sense were specially made by food manufacturers using mineral acids and by chemical manufacturers. Maltsters appear particularly desirous of a "standard" as regards arsenic in malt, capable of adoption not only in transactions with brewers, but also with manufacturers of malt foods and malt extracts.

H. HAMMOND SMITH.

October 1902.

ADDENDA TO REPORT OF MR. H. HAMMOND SMITH.

Appendix 24

A.—Arsenic in Glycerine: Extracts from Letters Received from Prof. Campbell Brown.

(December, 1901, and subsequently.)

It is quite true that several years ago glycerine had objectionable quantities of arsenic in it. We have occasionally tested glycerine, and found it pass the Pharmacopœia test, but we also found that by more prolonged experiments even the mercuric chloride paper showed a reaction. We never had enough glycerine to determine the arsenic by the "drastic method."

Marsh's test is discarded by us, and by a good analyst who regularly analyses commercial glycerine; he uses Reinsch's method. I cannot tell you the degree of delicacy. We are all agreed that the Pharmacopœia method is most unsatisfactory.

I shall be glad to send you what information I can gather. Meanwhile I append such references as I have.

J. Soc. Chem. Ind. 1889, 639 (Chem. Zeit. Rep. XII. 293). Qualitative only—2 c.c. Sample, 3 c.c. HCl Zn & Ag NO_3 paper.

J. Soc. Chem. Ind. 1889, 726 (Pharm. J. 1889, 205). As_4O_6 found in most samples, 1 part in 2,500—6,000, $HgCl_2$ test.

J. Soc. Chem. Ind. 1899, 404 (J. Amer. Chem. Soc. XXIX. 133). Quantitative—no figures given.

J. C. S. 1896, II., 519 (J. Amer. Chem. Soc. XVII. 683). Quantitative—no figures given.

J. C. S. 1899, II., 499. Quantitative—no figures given.

Pharm. J. 1899, 359 (Chem. Centr. bl. LX. II. 58).

Pharm. J., 1899, p. 968. English as well as German commercial glycerine contains arsenic "in notable quantity."

Pharm. J. 1899, p. 277. Siebold. Analysed many samples, both English and foreign; all were intended for pharmaceutical or toilet purposes, and were colourless and odourless. The majority contained 1 part As_4O_6 in 4,000 to 1 part in 6,000. A few contained larger quantities, and 10 per cent. of the samples contained smaller quantities. Those free from arsenic were all traced to the steam distillation process.

Method was to pass the gas from Marsh's apparatus into $AgNO_3$ solution, and weigh the precipitate.

For qualitative work Siebold recommends Gutzeit's test—5 c.c. HCl (4 per cent.) solution, 15-20 drops glycerine, 1 gramme Zn-1 drop saturated $HgCl_2$ solution dried on filter paper. 1-100th milligramme arsenic in 1 gramme sample shows a stain in a quarter of an hour. The contamination is probably due to the H_2SO_4 used in the manufacture. The amount of arsenic found would correspond to about 2 drops of Fowler's solution, which is serious (p. 682). The arsenic is not due to the glass bottles, nor to the solder of the drums. Gutzeit's test can be used quantitatively to estimate one part As_4O_6 in 50,000. (I do not think this is really so).

Pharm. J. 1890, p. 241, Siebold. Redistillation does not remove the arsenic from glycerine. It can be completely removed by diluting, adding freshly precipitated $Fe(OH)_3$, allowing to stand, and filtering.

Pharm. J. 1894, p. 588. Fairley, Public Analyst, Leeds, finds that five samples out of eight contained "appreciable quantities of arsenic."

p 685, Paul and Cownley. Of seven samples, three were free from arsenic, two contained ·01 milligram per c.c., and two contained ·001 milligram per c.c. Used Gutzeit test, operating on 2 c.c. sample. Commercial glycerine contained much more arsenic than the above samples.

Pharm. J. 1895, p. 802. Lewkowitsch says the arsenic is present as $As_2O_3(C_3H_5)$, which would distil over with the glycerine at 250°, and, therefore, the latter cannot be purified by distillation.

Pharm. J. 1895, p. 802. Tegarden. Seven samples contained "comparatively large amounts of arsenic," two contained minute traces, four were absolutely free. He used Gutzeit's test.

Commercial glycerine was taken, proved free from arsenic by Gutzeit's test for two hours, also by Scudder's form of Marsh's apparatus, and by Reinsch's method. To this were added different proportions of arsenious oxide. The following three *failed to give indications by B.P. tests*, but showed a yellow stain after a longer time, namely:—

·001 milligram arsenious oxide in 2 c.c. Glycerine showed slight stain in 1 hour.
·002 milligram arsenious oxide in 2 c.c. Glycerine showed faint stain in ½ hour.
·004 milligram arsenious oxide in 2 c.c. Glycerine showed faint stain in 20 minutes.

These are the proportions of ·05 parts per 100,000:—
·1 " " "
·2 " " "

The following proportions were *detected by the B.P. test*:—

·006 milligram in 2 c.c. Glycerine gave faint yellow stain in 15 minutes.
·008 milligram in 2 c.c. Glycerine gave stain just visible in 10 minutes.
·01 milligram in 2 c.c. Glycerine gave faint stain in 10 minutes.
·02 milligram in 2 c.c. Glycerine gave stain just beginning in 5 minutes; quite distinct in 6 minutes.

According to notes by a good consulting chemist, Mr. Charles C. Moore, who was examining glycerine before the beer scare, he had an initial difficulty in the absence of a recognised method of testing. The B.P. test gave no indication with samples containing very appreciable amounts of arsenic, and, although results were recorded, they were quite useless. He also tried, as a qualitative test, the Gutzeit test, using strong silver nitrate on filter paper, with a plug of cotton-wool inside the test tube. Ten c.c. of glycerine, 10 c.c. water, and 3 c.c. HCl, was used for each test. For pure glycerine this test is largely used by manufacturers. Mr. Moore says "if sufficient time is given, say half an hour, it is fairly delicate. Using the quantities just given, a glycerine containing ¼ part by weight of As_4O_6 per million parts by weight of glycerine, will give a distinct indication of arsenic. It is necessary to have the zinc in small pieces to ensure a current of gas. A rough idea of the amount of arsenic in a sample may be obtained by this test by adding a known amount of arsenic to perfectly pure glycerine (not more than 1-200th or 1-100th mgm. arsenious acid), and finding out the smallest quantity of the contaminated sample required to produce a corresponding stain. If larger amounts of arsenic are used it is useless trying to compare the stains produced. These results are of course only approximate, and probably too low, but they enable one to distinguish between several samples with ease.

Attempts to estimate the arsenic by precipitation with sulphuretted hydrogen, after diluting the sample with water and adding HCl were not successful, as it was impossible to obtain the slightest trace of any precipitate with samples containing as much as five or six parts per million of arsenious acid, even after long standing. As this is a larger amount of arsenious acid, by a long way, than is usually found in pure glycerine, it is obvious that results obtained by this method would be quite unreliable. Another way was tried to get results by using H_2S in the following manner:—

About 100 to 150 grammes of glycerine was evaporated to a small bulk (about 5 c.c.), a little caustic soda being added before evaporation, with the object of retaining the arsenic. The results when using glycerine to which known quantities of arsenic had been added were fairly good, although the method is certainly rather tedious.

On the following page are tabulated the results of the examination of a number of samples of glycerine, which I know to be of home manufacture.

Appendix 24.

TESTS OF PURE GLYCERINE FOR ARSENIC.

No. of Sample.	Qualitative test according to the British Pharmacopœia.	Gutzeit test with silver nitrate as described. Parts As_4O_6 per million glycerine.	Quantitative by evaporation as described. Parts As_4O_6 per million glycerine.
1	None.	0·15	—
2	„	0·45	—
3	„	3·5	·1
4	„	0·75	—
5	„	0·5	—
6	„	1·5	1·9
7		0·1	
8		0·1	
9	„	0·2	—
10	„	5·0	—
11	Trace.	5·5	5·2
12	„	7·5	9·2
13	None.	4·5	5·1
14	„	3·5	—
15	Trace.	8·0	9·4
16	None.	0·2	—
17	„	9·0	11·0
18	„	1·0	1·3

With reference to the above figures, I should consider the samples containing 0·25 part As_4O_6 per million (or less), as being free from arsenic, while those containing about 1·0 part As_4O_6 per million, may be considered as fairly good glycerines. Above that amount I would advise anyone to reject the glycerine as containing too much arsenic. Nearly all the bad samples in the above list were supposed to come from the same manufacturer, while *each* of the good samples represents a different manufacturer. As there are only about a dozen makers of pure glycerine in the country, it generally soon gets known in the trade if any brand falls below its standard.

Glycerine is now used in large quantities in the manufacture of cakes, I have been informed, which suggests an additional reason why its purity from arsenic should receive close attention. The whole of the samples mentioned above would, if judged by the standard of the British Pharmacopœia, have to be pronounced pure, although they show wide variations in the amount of arsenic. It appears that anyone selling glycerine containing an objectionable amount of arsenic might justify his action by contending that the requirements of the British Pharmacopœia were complied with. I can see no reason why such a contention should be considered unreasonable while there is no recognised standard of purity, as at present. There is no doubt, as I pointed out before, that nearly all the glycerine sold by home manufacturers is of far higher purity as regards arsenic than is required by the B.P. So that it seems reasonable to assume that the makers would welcome some higher and more definite standard than the present very lax one."

May, 1902.

I send you some results of comparative tests, made in the County laboratory, of the amount of arsenic in glycerine by different methods

Series 1.	Gutzeit, 2 c.c.		Reinsch, 25 c.c.	Marsh, 2 c.c.
	Thirty Minutes.	Two Hours.		
mples	No stain	No stain	No stain.	—
„	„	Faint stain	Slight tarnish.	—
sample	„	No stain	About ·001 grain per lb.	—
1 „	„	„	„ ·0013 „ „	—
1 „	„	„	„ ·002 „ „	—
1 „	„	Faint stain	„ ·0016 „ „	—
1 „	„	„ „	„ ·005 „ „	—
1 „	„	„ „	„ ·005 „ „	—
1 „	„	„ „	„ ·008 „ „	About ·006 grain per lb
1 „	Faint stain	„ „	„ ·008 „ „	„ ·006 „ „
1 „	„ „	„ „	„ ·016 „ „	„ ·02 „ „

Series II.	Gutzeit, 2 c.c., yellow in	Reinsch, 25 c.c.	Marsh, 2 c.c.	Weighing As_2S_3 from about 1 lb.
1 sample	20 minutes	·01	·008	—
1 the same, larger sample	15 „	—	—	·013 grain
1 sample	18 „	·02	·0084	—
1 the same, larger sample	15 „	—	—	·02 grain
1 sample	18 „	·033	·02	—
1 the same, larger sample	11 „	·04	—	·057 grain
1 sample	8 „	·08	·05	—
1 the same, larger sample	8 „	·08	—	·0994 grain
Commercial brown glycerine	—	—	—	·74 grain

N.B.—In the case of the samples bracketed, the second sample was a further quantity of the same glycerine obtained for the purpose of determining the quantity by an exact method.

The Reinsch method gives more nearly the correct figure than the Marsh method, and the true figure is always slightly greater than either.

B.—Arsenic in Gas Coals, Gas Products, and Coal Gas.

COPY OF LETTER AND ENCLOSURES RECEIVED FROM MR. T. FAIRLEY, CITY AND COUNTY ANALYST, OF LEEDS.

17, East Parade,
Leeds,
22nd June, 1903.

Dear Dr. Buchanan,—I enclose tabulated numbers relating to analyses of coals and their gas products for arsenic.

In no case have we been able to find arsenic in coal gas—though the tests applied would have detected 0·00002 or 1/50,000 grain per cubic foot.

Should you require the full analyses of these gas coals they are at your disposal. Yours faithfully,

T. Fairley.

ANALYSIS OF YORKSHIRE GAS COALS.

	Coal.					Coke.			Liquor.		Tar.	
	Cubic Feet of Gas per Ton.	Illuminating Power.	Percentage of Ash.	Percentage of Sulphur.	Arsenic in grains per lb.	Percentage of Coke in Coal.	Percentage of Sulphur.	Arsenic in grains per lb.	Percentage of Liquor.	Arsenic in grains per lb.	Percentage of Tar.	Arsenic in grains per lb.
No. 1	10,950	18·4	7·7	3·5	0·036	64·6	2·90	0·036	9·7	0·063	10·7	0·065
No. 2	10,625	18·7	8·5	4·7	0·012	64·8	1·10	0·007	5·0	0·031	5·0	0·070
No. 3	11,000	18·4	4·6	1·3	0·015	64·4	0·76	0·009	6·4	0·035	7·5	0·037
No. 4	10,560	17·8	8·4	5·1	0·140	60·9	3·40	0·119	8·9	0·056	8·6	0·168
No. 5	11,249	15·7	2·1	2·1	0·003	56·6	1·90	0·003	5·4	0·005	5·8	0·004

ANALYSIS OF YORKSHIRE GAS COALS—*continued.*

Arsenic in Grains per lb. of Coal.

	Coal.	Coke.	Liquor.	Tar.	Absorbed in Lime Purifiers (by difference).
Coal No. 1	0·036	0·0230	0·0060	0·0070	None.
Coal No. 2	0·012	0·0045	0·0015	0·0035	0·0025
Coal No. 3	0·015	0·0058	0·0022	0·0027	0·0043
Coal No. 4	0·140	0·0720	0·0050	0·0140	0·0490
Coal No. 5	0·003	0·0017	0·0002	0·0002	0·0009
Average	0·041	0·0214	0·0029	0·0055	

APPENDIX 25.

REPORT BY DR. G. McGOWAN ON EXAMINATION FOR ARSENIC OF VARIOUS SUBSTANCES SENT TO HIM IN CONNECTION WITH MR. H. HAMMOND SMITH'S INQUIRY.

The results of the examination for arsenic of the various food and other substances submitted to me in connection with Mr. Hammond Smith's inquiry are set out in the accompanying Tables I. to III. The substances in question were of widely different nature and a variety of methods of treatment, preliminary to estimation of arsenic by the Marsh Berzelius test, had to be adopted accordingly. The tables indicate in the case of each substance the procedure adopted, and also show the basis on which the quantity of arsenic in the substance was calculated from the mirror or mirrors read. A full account of the various methods employed appears in the paper by Mr. R. S. Finlow B.Sc., and myself, which is separately printed as Appendix 22 above. Here I would only add that the analytical work in connection with the substances recorded in these tables, as also in connection with the foods and other specimens submitted to me by the Commission in connection with the beri-beri inquiry (Appendix 31, Tables IV. to VI.) and the enamelled cooking utensils inquiry (Appendix 29), was carried out in my laboratory almost entirely by Mr. Finlow, to whom I would express my great indebtedness, both for the care and thoroughness with which he has carried this through and for introducing modifications and improvements in the methods as the investigations progressed.

GEORGE McGOWAN.

Ealing, August, 1903.

TABLE I.—Miscellaneous Food Substances.

TABLE II.—Specimens received in connection with Experiments on (*a*) Gooseberries and (*b*) Fowls.

TABLE III.—Miscellaneous Substances other than Foods.

APPENDIX, No. 25

TABLE I.

SHOWING RESULTS OF EXAMINATION FOR ARSENIC OF MISCELLANEOUS FOOD SUBSTANCES RECEIVED FROM THE COMMISSION.

1. Number of Sample.	2. Description of Sample.	3. Date when Analysed.	4. Quantity taken for Analysis.	5. Method of Analysis.	6. Arsenic mirror read. (Milligrammes.)	7. Arsenic ($As_4 O_6$) in grains per lb. Approximate fractions.	8. Parts per Million.	9. Notes as to Analysis.
	PREPARATIONS OF MALT, OR FOODS CONTAINING MALT:							
1	Maltine	17 Jan. 1903	5·0 grms.	Direct Marshing	Merest trace	Arsenic-free	—	25·0 grms. were made up with water to 100 c.c., and 20 c.c. of this were taken.
2	Kepler's Malt Extract	22 Dec. 1902	4·07 grms.	ditto	Merest trace	Arsenic-free	—	40·7 grms. were made up to 200 c.c. with water, and 20 c.c. of this were used. 1 c.c. amyl alcohol was added in the Marsh flask, to prevent frothing.
3	* "Grape Nuts"	4 Nov. 1902	5·0 grms.	Nitric and sulphuric acids	Merest trace	Arsenic-free	—	The whole of the extract was Marshed.
4	* Horlick's Malted Milk	31 Oct. 1902	5·0 grms.	ditto ditto	None	Arsenic-free	—	ditto ditto.
5*a*	"Carnos," I. Purchased July 1901.	(*a*) 29 July 1901	2·5 grms.	Direct Marshing (preliminary estimation).	·01 to ·015	$\frac{1}{25}$ approximately	5·7 approximately	This was an early estimation, and is merely to be taken as *qualitative*.
5*b*	"Carnos," I. Purchased July 1901.	(*b*) 27 Feb. 1902	5·7 grms.	Nitric and sulphuric acids	·0135	$\frac{1}{24}$	6·0	The mirror read represented two-fifths of the whole extract, *i.e.*, 2·28 grms. of Carnos.
6	* "Carnos," II. Obtained at factory, 9th November 1901.	6 Mar. 1902	5·7 grms.	ditto ditto	·0145	$\frac{1}{22}$	6·4	The mirror read again represented two-fifths of the whole extract.
	"Carnos," III. Purchased 14th May 1902.	26 June 1902	6·7 grms.	ditto ditto	·017	$\frac{1}{6}$	25	The mirror represents one-tenth of the whole extract.
7	"Carnos," III. Purchased 14th May 1902	26 June 1902	5·01 grms.	ditto ditto	·0173	$\frac{1}{6}$	24	The mirror represents one-seventh of the extract.

	MEAT AND MILK PREPARATIONS:							
*	"Carnigen" . . . . Received 11th October 1902.	13 Nov. 1902	5·0 grms.	Nitric and sulphuric acids	0·001 or trace	Mere trace	0·1 to 0·2	The whole extract from the 5 grammes was Marshed.
9	Valentine's Meat Juice . . Purchased 22nd August 1902.	28 Jan. 1903	5·0 grms.	ditto ditto	0·0015 or trace	say $\frac{1}{750}$	Trace to 0·3	The whole extract was Marshed.
10	* "Somatose"	9 Sept. 1902	5·0 grms.	ditto ditto	0·0013	$\frac{1}{550}$	0·26	ditto ditto.
11	* "Casumen" . . . . Received 11th October 1902.	12 Nov. 1902	5·0 grms.	ditto ditto	None	Arsenic-free	—	ditto ditto.
	CEREAL PREPARATIONS:							
12	* "Cream of Wheat" . . . Received 11th October 1902.	14 Nov. 1902	5·0 grms.	ditto ditto	None	Arsenic-free		ditto ditto.
13	"Self-raising Flour" . . . Purchased 22nd August 1902.	15 Nov. 1902	5·0 grms.	ditto ditto	None or trace	Arsenic-free	—	ditto ditto.
14	"Benger's Food" . . . Purchased 22nd August 1902.	12 Nov. 1902	5·0 grms.	ditto ditto	Trace	Trace	—	The whole extract was Marshed. This sample went into solution easily. A little calcium sulphate came down in the extract, this indicating the probable presence originally of phosphate of lime.
	DEMERARA SUGARS:							
15	No. 1. Common Demerara (London retailer A.) Received 14th October 1902.	21 Oct. 1902	10·0 grms.	Direct Marshing with hydrochloric acid.	Merest trace, or none.	Arsenic-free	—	The whole was Marshed.
6	No. 2. Best Demerara . . (London retailer A.) Received 14th October 1902.	21 Oct. 1902	10·0 grms.	ditto ditto	0·0023	$\frac{1}{600}$	0·23	ditto ditto.
17	No. 3. Raw Brown Moist Sugar (London retailer A.) Received 14th October 1902.	25 Oct. 1902	10·0 grms.	ditto ditto	Too small to read.	Arsenic-free	—	ditto ditto.

APPENDIX, No. 25—*continued*.

TABLE I.—Showing Results of Examination for Arsenic of Miscellaneous Food Substances Received from the Commission—*continued*.

1. Number of Sample.	2. Description of Sample.	3. Date when Analysed.	4. Quantity taken for Analysis.	5. Method of Analysis.	6. Arsenic mirror read. (Milligrammes).	7. Arsenic ($As_4 O_6$) in grains per lb. Approximate fractions.	8. Parts per Million.	9. Notes as to Analysis.
	DEMERARA SUGARS—*continued*.							
18	Demerara (London retailer B.) Received 11th October 1902.	31 Oct. 1902	10·0 grms.	Direct Marshing with hydrochloric acid.	None	Arsenic-free	—	The whole extract was Marshed.
19	Raw Brown Demerara (Retailer C.) Received 11th October 1902.	29 Oct. 1902	10·0 grms.	ditto	0·0015	$\frac{1}{1000}$	0·15	ditto
20	Best Demerara (Retailer C.) Received 11th October 1902.	30 Oct. 1902	10·0 grms.	ditto	Trace	Trace	—	ditto
21	Demerara (Retailer D.) Received 11th October 1902.	27 Oct. 1902	10·0 grms.	ditto	None	Arsenic-free	—	ditto
22	Demerara (Retailer E.) Received 11th October 1902.	25 Oct. 1902	10·0 grms.	ditto	0·0019	$\frac{1}{750}$	0·19	ditto
23	Demerara (Retailer F.) Received 11th October 1902.	27 Oct. 1902	10·0 grms.	ditto	0·0035	$\frac{1}{400}$	0·35	ditto
24	Large white crystal sugar. Sample submitted on account of unusual acid taste.	About 25 Mar. 1903.	5·0 grms.	ditto	None	Arsenic-free	—	This sample was very acid to the taste, and was found to contain acid equivalent to 0·95 per cent. of tartaric acid. It contained no mineral matter, no heavy metals, and no sulphuric, hydrochloric, or oxalic acid. The acid present appeared to resemble tartaric more than citric. Without having gone very minutely into the matter, one may surmise that the sample contained about 1 per cent. of tartaric acid.
	PREPARED TABLE SALT:							
24*	"Cerebos" Salt	8 Aug. 1903	2·5 grms.	ditto	Merest trace	Arsenic-free	—	

	TABLE SYRUP:							
25	* Bostock's Table Syrup I., made with invert sugar. Received 15th June 1901.	(*a*) 19 June 1901.	10·0 grms.	Direct Marshing with sulphuric acid.	Dense black mirror.	—	—	(*b*) 2·0 c.c. of the solution (=0·288 grm.) were Marshed. This mirror was too dense to read with great accuracy, but must be nearly right.
		(*b*) 29 October 1902.	28·8 grms. in 200 c.c. water.	Direct Marshing with hydrochloric acid.	0·04	1·0	140·0	
26	Bostock's Table Syrup II., made without invert sugar. Received 15th June 1901.	20 June 1901	10·0 grms.	Direct Marshing with sulphuric acid.	None, or at any rate, merest trace.	Arsenic-free	—	The whole was Marshed.
	PRESERVATIVE:							
27	* Frigiline 24th April 1901.	16 Jan. 1903	5·0 grms.	Direct Marshing of the hydrochloric acid solution of the powdered substance.	0·035	$\frac{1}{21}$	7·0	The whole extract Marshed. *Note.*—This substance evidently contained boracic acid and the whole did not go into solution with hydrochloric acid.
	BAKING POWDERS:							
28	Baking Powder (From a baker's.)	(*a*) 3 Dec. 1901	1·0 grm.	(*a*) Direct Marshing of hydrochloric acid solution (not all soluble.)	None	—	—	(*a*) Whole solution Marshed.
		(*b*) 15 Mar. 1902	3·0 grms.	(*b*) Basic method, followed by Marshing of the hydrochloric acid extract.	0·0045	$\frac{1}{60}$	2·6	(*b*) Three-fifths of extract Marshed. This was a white powder of strongly acid re-action, insoluble in water, partly soluble in hydrochloric acid. It contained organic matter, and also some phosphate or phosphoric acid.
29	* Acid Phosphate of Lime, used in baking powder. Received 11th October 1902.	24 Oct. 1902	10·0 grms.	Basic method, followed by Marshing of the hydrochloric acid solution ultimately obtained.	0·012	$\frac{4}{5}$	120·0	One-hundredth part of extract Marshed. (The first mirror from one-tenth part was much too dense to read.) The whole of the lime residue did not dissolve in hydrochloric acid; the solution contained a little iron.
	POWDERS FOR BEVERAGES, CONTAINING CITRIC OR TARTARIC ACID:							
30	* Fruit Crystals	20 June 1902	5·0 grms.	Direct Marshing of the hydrochloric acid solution.	None	Arsenic-free	—	Whole extract Marshed.
31	* "Eiffel Tower Lemonade"	19 June 1902	(*a*) 2·0 grms.	ditto ditto	None	Arsenic-free	—	(*a*) Whole extract Marshed.
			(*b*) 5·0 grms.		None	Arsenic-free	—	(*b*) Whole extract Marshed.
32	Sherbet	25 June 1902	5·0 grms.	Direct Marshing with hydrochloric acid.	None	Arsenic-free	—	Whole extract Marshed. The carbonic acid was boiled off before the hydrochloric acid was added.

APPENDIX, No. 25—*continued.*

TABLE I.—Showing Results of Examination for Arsenic of Miscellaneous Food Substances received from the Commission—*continued.*

1. Number of Sample.	2. Description of Sample.	3. Date when Analysed.	4. Quantity taken for Analysis.	5. Method of Analysis.	6. Arsenic mirror read. (Milligrammes.)	7. Arsenic ($As_4 O_6$) in grains per lb. Approximate fractions.	8. Parts per Million.	9. Notes as to Analysis.
	POWDERS FOR BEVERAGES, CONTAINING CITRIC OR TARTARIC ACID—*continued.*							
	Seidlitz Powder:							
33*a*	(*a*) Acid powder	12 June 1902	3·0 grms.	Direct Marshing of the hydrochloric acid solution.	None	Arsenic-free	—	Two-thirds of extract Marshed.
33*b*	(*b*) Alkaline powder	12 June 1902	(*a*) 5·0 grms.	Direct Marshing of the *reduced* sulphuric acid solution.	Trace, say, 0·001.	$\frac{1}{800}$ (?)	—	(*a*) Whole extract Marshed: a little sulphide was generated in the Marshing.
		14 June 1902	(*b*) 6·17 grms.	Direct Marshing of the *unreduced* sulphuric acid solution.	None	Arsenic-free	—	(*b*) Whole extract Marshed. *Note.*—Estimation (*b*) is probably the more reliable of the two.
	GELATINES:							
34	*Granulated Jelly (vanilla flavour) packet (Manufacturer A).	1 April 1903	30·0 grms.	Dissolved in hydrochloric acid, 1½ grms. of chlorate added, the chlorine boiled off, and the solution Marshed directly.	None	Arsenic-free	—	One-fifth of the ultimate extract was Marshed.
35	Cox's Gelatine, packet	1 April 1903	12·8 grms.	Done in same way as preceding sample, but only 0·75 grm. chlorate was used.	Trace, say, 0·00075.	about $\frac{1}{1000}$	0·15	Two-fifths of extract Marshed.
36	* Gelatine (German) from a sweetmeat maker.	28 Mar. 1903	15·3 grms.	Done as above, with only a small amount of chlorate,—say, half a gramme.	None	Arsenic-free	—	Two-sevenths of extract Marshed.
37	* Gelatine from Manufacturer B.	28 Mar. 1903	12·0 grms.	Done as above, using 1·0 grm. of chlorate.	0·0037	$\frac{1}{140}$	1·1	Two-sevenths of extract Marshed.

	VEGETABLES:							
	Early Guernsey Potatoes (grown on soil heavily manured):							
38*a*	Flesh of potatoes	4 July 1901	100 grms.	Digestion with carbonate of ammonia and subsequent Marshing of the filtered solution.	None or trace	Arsenic-free	—	$\frac{1}{12}$ths of solution Marshed. This must merely be regarded as qualitative.
38*b*	Skin of potatoes (*a*)	4 July 1901	100 grms.	Digested with aqueous hydrochloric acid for about two hours and "Reinsched" the solution.	None or trace	Arsenic-free	—	This, too, should be regarded as qualitative.
38*c*	Skin of potatoes (*b*)	5 July 1901	50 grms.	Distilled with concentrated hydrochloric acid, diluted the distillate and precipitated with sulphuretted hydrogen.	0·02 approx.	$\frac{1}{350}$	0·4	The whole extract Marshed.
–	Plums (Fresh plums from an unknown source, received 5th September 1901.)	(*a*) 5 Sept. 1901	288 grms.	Digested with dilute hydrochloric acid and "Reinsched" the solution.	—	Arsenic-free	—	No signs of arsenic crystals from the very faint sublimate obtained.
		(*b*) 5 Sept. 1901	328 grms.	Extracted with aqueous carbonate of ammonia and treated the evaporated extract with nitric and sulphuric acids.	0·005	Arsenic-free	—	The whole extract Marshed.
	SWEETENING SUBSTANCE:							
39	*Porcherine, for aerated waters	2 April 1903	30·0 grms.	Chlorate method	0·01	$\frac{1}{200}$	0·5	Five-eighths of extract Marshed. *Note.*—This Sample gave a white crystalline precipitate with hydrochloric acid, which persisted after treatment with chlorate. From its behaviour it was probably saccharine.
	LIQUORICE:							
40	*Raw Liquorice	6 Aug. 1902	7·5 grms.	Nitric and sulphuric acids	0·0045	$\frac{1}{250}$	0·6	This sample was refractory to deal with. The whole extract was Marshed.
41	*Italian Liquorice Stick	28 Jan. 1903	5·0 grms.	ditto ditto	0·001	$\frac{1}{750}$	0·2	The whole extract was Marshed.
42	*Italian Liquorice Cake	29 Jan. 1903	3·8 grms.	ditto ditto	0·0015	$\frac{1}{400}$	0·38	The whole extract was Marshed. (A very small quantity was lost, nothing of any consequence).
43	*Russian Liquorice Juice	10 Feb. 1903	5·0 grms.	ditto ditto	Merest trace	Arsenic-free	—	This juice was made into a syrup with water before treatment with the acids. The whole extract was Marshed.

APPENDIX, No. 25—*continued*.

TABLE I.—Showing Results of Examination for Arsenic of Miscellaneous Food Substances received from the Commission—*continued*.

1. Number of Sample.	2. Description of Sample.	3. Date when Analysed.	4. Quantity taken for Analysis.	5. Method of Analysis.	6. Arsenic mirror read. (Milligrammes).	7 Arsenic ($As_4 O_6$) in grains per lb. Approximate fractions.	8. Parts per Million.	9. Notes as to Analysis.
	COLOURING MATTERS:							
44	*Bole Armenia (From one of the London "Stores.")	(*a*) 21 May 1902	5·0 grms.	Basic method, followed by direct Marshing.	Too dense to read.	—	—	(*a*) Whole extract Marshed.
		(*b*) 22 May 1902	1·01 grms.	- ditto - ditto - -	0·0012	$\frac{4}{5}$	115·0	(*b*) One-tenth of extract Marshed.
		(*c*) 24 May 1902	1·05 grms.	- ditto - ditto - -	0·00135	$\frac{9}{10}$	129·0	(*c*) One-tenth of extract Marshed Not very much iron went into solution, but the results should be regarded as approximate. (*c.f.* Appendix 23.)
45	*Bole Armenia (Smithfield.)	4 March 1903	5·0 grms.	Basic method, followed by precipitation as sulphide.	0·031	$\frac{1}{11}$	12·4	Half of the extract was Marshed. This sample was mainly composed of inorganic material.
46	*Apple Green (From sweet maker.)	5 Aug. 1902 -	(*a*) 0·5 grm.	Direct Marshing - - -	(*a*) No mirror.	—	—	—
			(*b*) 1·67 grms.	Nitric and sulphuric acids -	(*b*) 0·016	$\frac{1}{12}$	11·5	Five-sixths of extract Marshed. This was a very small sample.
47	Coffee Colour (From sweet maker.)	4 March 1903	1·375 grms.	Basic method, followed by precipitation as sulphide.	0·026	$\frac{1}{4}$	38·0	Half of extract Marshed.
48	"Saster" (brown colouring matter from sausage makers).	3 March 1903	5·0 grms.	- ditto - ditto - -	0·0075	$\frac{1}{50}$	3·0	Half the extract was Marshed. This sample was mainly of inorganic material.
49	Commercial Chloride of Tin (Obtained from the Society of Apothecaries in view of use of this substance to colour Demerara sugar).	31 Oct. 1902 -	2·5 grms.	Precipitation as sulphide and extraction of this precipitate with ammonium carbonate (both operations repeated twice). The second extract was worked up in the usual way for sulphide precipitates.	0·0015	$\frac{1}{14}$	10·0	$\frac{1}{14}$ths of extract Marshed. *Note.*—This result is to be taken as approximate only. The mirror read was very small and the multiplication error was no doubt proportionately large. According to Bettendorf's test, this sample contained only a trace of arsenic (8th November 1902).

Appendix 25.

50	Dragon's Blood - - - - (from sweet maker, 11th June 1902.)	14 Mar. 1903 -	3·0 grms.	Basic method followed by direct Marshing.	0·003	$\frac{1}{40}$	3·5	Two-sevenths of extract Marshed. This sample was almost wholly organic. It was a powder.
51	Carmine Colouring Matter - (from sweet maker, 11th June 1902.)	14 Mar. 1903 -	3·0 grms.	- ditto - ditto -	0·002	$\frac{1}{130}$	1·1	Three-fifths of extract Marshed. This sample was largely, if not wholly, organic. It was a powder.
52	Carmation Colour - - - - (from sweet maker, 11th June 1902.)	14 Mar. 1903 -	0·55 grms. (of the paste).	- ditto - ditto -	0·031	$\frac{7}{10}$	103·0	20 c.c. out of a total of 37 c.c. were Marshed. This was a sticky paste, not a dry powder.
	SMOKED OR DRIED FOODS:							
	Chicory. (Fuel used for drying not known.) (From chicory roaster and importer:							
53	*Sample A. (" Raw chicory as received from Holland.")	6 Aug. 1902 -	5·0 grms.	Nitric and sulphuric acids -	0·001	$\frac{1}{730}$	0·2	Whole extract Marshed.
54	*Sample B. (Chicory dried and ground, ready for roasting in open pans.)	4 Sept. 1902 -	5·0 grms.	- ditto - ditto -	0·001	$\frac{1}{730}$	0·2	- ditto - ditto.
55	*Sample C. (Chicory, same as B., after roasting in open pans.)	4 Sept. 1902 -	5·0 grms.	- ditto - ditto -	0·001	$\frac{1}{730}$	0·2	- ditto - ditto.
56	*Sample D. (Chicory, ground, after roasting in cylinders; not from same bulk as A., B., and C.)	5 Sept. 1902 -	5·0 grms.	- ditto - ditto -	0·0038	$\frac{1}{200}$	0·75	- ditto - ditto.
57	*Coffee, roasted over gas coke fire. (18th July 1902.)	25 Mar. 1903 -	50·0 grms.	Extraction for 15 minutes at 50° C. with dilute hydrochloric acid, and subsequent direct Marshing.	0·001	$\frac{1}{730}$	0·2	The equivalent of 5 grms. coffee was Marshed.
58	*Lemon peel, dried over gas coke. (17th June 1901.)	28 Mar. 1903 -	33·0 grms.	Chlorate method - - -	0·01	$\frac{1}{470}$	0·3	Whole extract Marshed.

APPENDIX, No. 25—*continued.*

TABLE I.—Shewing Results of Examination for Arsenic of Miscellaneous Food Substances received from the Commission—*continued.*

1. Number of Sample.	2. Description of Sample.	3. Date when Analysed.	4. Quantity taken for Analysis.	5. Method of Analysis.	6. Arsenic mirror read. (Milligrammes.)	7. Arsenic ($As_4 O_6$) in grains per lb. Approximate fractions.	8. Parts per Million.	9. Notes as to Analysis.
	SMOKED OR DRIED FOODS—*continued.*							
	Ham (dried over London gas coke). Received 12th July 1901. This ham weighed 12½ lbs. :							
59a	Knuckle end (6½ lbs.) :							
	(1) Steep water	Begun 14 July 1901. July–Oct. 1901.	Whole of steep water.	(1) Knuckle-end steeped for 13½ hours on 14–15th July, the steep water concentrated 15–16th July, finally with addition of hydrochloric acid, and then the filtered solution precipitated as sulphide.	0·065	Trace (calculated on the 6½ lbs. of knuckle).	0·02	Whole extract Marshed.
	(2) Boil water	Begun 17 July 1901. July–Oct. 1901.	¾ of the whole boil water.	(2) The above knuckle-end, after steeping, was boiled with water in an enamelled saucepan for 3½ hours, a portion of the liquid was evaporated down, finally with addition of hydrochloric acid, and the filtered solution was precipitated as sulphide.	0·02	Trace (calculated on the 6½ lbs. of knuckle).	0·03	- ditto - ditto. 1. Though not probable, it is possible that the two results (1) and (2) may have been transposed. 2. There is no guarantee that the small quantity of arsenic found did not come from the enamelled pot. 3. It is, perhaps, hardly correct to calculate the arsenic found on the 6½ lbs. of ham ; it might be better to do it on the liquid extract, as such an extract may be used as stock for soups. But even in that case the quantity of arsenic comes out very small.

Appendix 25.

596	Skin and outer scrapings of ham, 12th July 1901. These weighed 489 grammes (a few small pieces with spots of mould were rejected), and contained about 10 per cent. of moisture. They were dried in a steam oven and set aside in a glass jar, which was covered with paper and cotton wool soaked in formalin.	(*x*) 19 Nov. 1901	70·0 grms.	Chlorate method		0·025	$\frac{1}{400}$ (calculated on the dried skin).	0·36	Whole extract Marshed.	
		(*y*) 19 Nov. 1901	—	—		—	—	—	An estimation of the arsenic in this skin was also attempted by the nitric and sulphuric acids method, but it proved unsatisfactory owing to the large amount of fat in the sample.	
	* Bloaters from Mr. Hodman, Hull. Received 8th April 1902. (I.*c*) From bottom layer of coke-room.									
92c	Flesh - - - - -	9 April 1902 -	102·2 grms.	ditto		0·043	$\frac{1}{850}$	0·4	The whole of the extract Marshed.	
96	Skin - - - - -	9 April 1902 -	56·3 grms.	ditto		0·085	$\frac{1}{1100}$, *i.e.*, trace	0·1	Two-thirds of extract Marshed.	
	(I.*b*) From top layer of coke-room, *i.e.*, furthest from fire.									
61c	Flesh - - - - -	8 April 1902 -	131·6 grms.	ditto		0·012	$\frac{1}{1600}$, *i.e.*, trace	0·1	Whole extract Marshed.	
61b	Skin - - - - -	8 April 1902 -	67·7 grms.	ditto		0·022	$\frac{1}{430}$	0·3	Whole extract Marshed. The above samples were examined fresh.	
	Bloaters from Messrs. Tether and Son, Hull. Received 8th April 1902. (II.*c*) From bottom layer of coke-room (*i.e.*, nearest to coke fire).									
62	Skin - - - - -	15 May 1902 -	74·3 grms.	ditto		0·033	$\frac{1}{300}$	0·7	Two-thirds of extract Marshed.	
	(II.*b*) From top layer of coke-room.									
63	Skin - - - - -	15 May 1902 -	76·9 grms.	ditto		0·034	$\frac{1}{290}$	0·7	Two-thirds of extract Marshed. The above were examined when considerably mouldy.	
	Bloaters from Mr. H. Moody, Hull. Received 10th April 1902. (III.*c*) From bottom layer of coke-room (*i.e.*, nearest to coke fire).									
64	Skin - - - - -	16 May 1902 -	32·2 grms.	ditto		0·0075	$\frac{1}{400}$	0·3	Two-thirds of extract Marshed.	
65	(III.*b*) From top layer of coke-room.	16 May 1902 -	36·5 grms.	ditto		0·0075	$\frac{1}{450}$	0·3	Two-thirds of extract Marshed. The above were examined when mouldy.	

APPENDIX, No. 25 —*continued.*

TABLE I.—Showing Results of Examination for Arsenic of Miscellaneous Food Substances received from the Commission—*continued.*

1. Number of Sample.	2. Description of Sample.	3. Date when Analysed.	4. Quantity taken for Analysis.	5. Method of Analysis.	6. Arsenic mirror read. (Milligrammes.)	7. Arsenic ($As._4 O_6$) in grains per lb. Approximate fractions.	8. Parts per Million.	9 Notes as to Analysis.
	SMOKED OR DRIED FOODS—*continued.*							
	Bloaters from Messrs. Hibbert, Bradford. Received 10th April 1902. (IV.*a*) From bottom layer of coke-room (*i.e.*, nearest to coke fire).							
66	Skin	21 May 1902	46·1 grms.	Chlorate method	0·031	$\frac{1}{140}$	1·0	Not examined until putrefying; not much mould. Two-thirds of extract Marshed.
	Bloaters from Mr. Fletcher, Bradford. Received 10th April 1902.							
67	(V.*a*) From top layer of coke-room.	21 May 1902	50·0 grms.	ditto	0·024	$\frac{1}{200}$	0·7	Not examined until putrefying; not much mould. Two-thirds of extract Marshed.
68	Bloaters. Exuded liquor from eight bloaters (from Fletcher, Bradford, and Hibbert, Bradford). Bloaters received 9th April 1902.	21 May 1902	The whole of the liquid (not weighed).	ditto	0·0018	Arsenic-free	—	Two-thirds of the ultimate extract was Marshed.
	Smoked Herrings. Received July 1902.							
69*a*	(*a.*) Skin of medium herring.	2 July 1902	Whole skin of one herring.	Extraction with ammonium carbonate and subsequent direct Marshing of the solution.	Negligible trace.	—	—	(*a.*) Whole extract Marshed. It would not do to depend on this estimation for a quantitative result.
69*b*	(*b.*) Skin of large herring	2 July 1902	Whole skin	Digestion with hydrochloric acid and "Reinsching" of the extract.	Trace, if any	Arsenic-free	—	——
69*c*	(*c.*) Skin of medium herring weighing 104 grms.	3 July 1902	Whole skin (= 36·0 grms).	Distilled with hydrochloric acid alone, filtered the distillate and precipitated with sulphuretted hydrogen.	0·01 (very approximate).	$\frac{1}{350}$	0·4	Whole extract Marshed.

NOTE.—Samples marked * in column 2 of this table were given to Mr. Hammond Smith by manufacturers or wholesale dealers. Other samples were purchased from retailers.

TABLE II.

SHOWING RESULTS OF EXAMINATION FOR ARSENIC OF SPECIAL SAMPLES RECEIVED IN CONNECTION WITH MR. H. SMITH'S EXPERIMENTS ON GOOSEBERRIES AND FOWLS.

1. Description of Sample.	2. Date when Analysed.	3. Quantity taken for Analysis.	4. Method of Analysis.	5. Arsenic Mirror read. (Milligrammes.)	6. Arsenic ($As_4 O_6$). Grains per lb. Approximate fractions.	7. Parts per Million.	8. Notes as to Analysis.
GOOSEBERRIES WATERED WITH PARIS GREEN:							
Gooseberries, No. 1.—Gathered eight days after watering.	24 July 1901	127·5 grms.	(*a*) Digestion for three hours with dilute ammonium carbonate, and subsequent "Reinsching" of the filtered solution.	A large number of well-defined octahedra.	—	—	—
Gooseberries, No. 1.—Gathered eight days after watering.	24 July 1901	127·5 grms.	(*b*) Digestion with very dilute hydrochloric acid for about three hours, and fractional precipitation of the filtered liquid by sulphuretted hydrogen. Part of this bulky precipitate was subsequently worked up with chlorate.	0·035 (Different volumes of two extracts used.) 0·035	$\frac{1}{20}$	6·8	—
Gooseberries, No. 2.—Gathered 28 days after watering.	13 Aug. 1901	25·5 grms. (This was the whole of the sample.)	Digestion with dilute ammonium carbonate for 1½ hours, and subsequent treatment of the evaporated syrup with nitric and sulphuric acids.	0·06 approx.	$\frac{1}{60}$	2·4	Unfortunately the whole extract was Marshed, the resulting mirror being too dense to read with accuracy.
FOWLS TO WHICH ARSENIC WAS ADMINISTERED:							
Fowler's Solution used in experiment.	2 June 1903	5 c.c.	Direct Marshing, after steaming off the volatile oil present.	0·009	—	9000·0 (Theoretically this should give 10,000 parts per million.)	$\frac{1}{5000}$ of the original 5 c.c. were Marshed, *i.e.*, $\frac{1}{1000}$ c.c.
Fowl, No. 5:—							
Liver and heart	30 Oct. 1901	55 grms. (*i.e.*, whole sample.)	Chlorate method	0·025	$\frac{1}{200}$	0·7	Three-fourths of solution Marshed, after preliminary trial with one-fourth.
Gizzard	30 Oct. 1901	41 grms. (*i.e.*, whole sample.)	ditto	0·008	$\frac{1}{600}$	0·2	Three-fourths Marshed, after preliminary trial with one-fourth.
Flesh (half of the breast and the flesh of one leg).	31 Oct. 1901	267·3 grms.	ditto	0·017	$\frac{1}{550}$	0·3	One-fourth of extract Marshed.
Fowl, No. 6:—							
Liver	28 Nov. 1901	47·3 grms. (*i.e.*, whole sample.)	ditto	0·025	$\frac{1}{200}$	0·7	Three-fourths Marshed, after trying one-fourth.
Coarse feathers	28 Nov. 1901	8·0 grms.	ditto	0·023	$\frac{2}{5}$	58·0	One-twentieth of extract Marshed, after four trials with larger quantities.
Medium and fine feathers (about equal weights of each).	28 Nov. 1901	8·5 grms.	ditto	0·019	$\frac{1}{5}$	28·0	Four-fiftieths Marshed, after two preliminary trials.

APPENDIX No. 25—*continued.*

TABLE III.

SHOWING RESULTS OF EXAMINATION OF CERTAIN MISCELLANEOUS SUBSTANCES (OTHER THAN FOOD) FOR ARSENIC.

1. Description of Sample.		2. Date when Analysed.	3. Quantity taken for Analysis.	4. Method of Analysis.	5. Arsenic mirror read. (Milligrammes).	6. Arsenic ($As_4 O_6$). Grains per lb. Approximate fractions.	7. Parts per Million.	8. Notes as to Analysis.
CIGARETTE PAPERS WITH METALLED TIPS:								
A. Bronze, made and sold by a firm in the East of London (labelled "Commonest," 6*d.*)	(*a*) Paper	21 May 1903	3·0 grms.	Basic method (lime water + lime), and Marshing with hydrochloric acid.	0·0015	$\frac{1}{200}$	0·7	Seven-tenths of extract Marshed.
Tips. Uncovered Paper.								
Lengths (cms.) 1·25 5·7	(*b*) Tips (including the paper under the metal).	21 May 1903	0·5 grm.	Chlorate method	0·0135	$\frac{9}{10}$	135·0	One-fifth of the extract was Marshed.
Weights (grms.) 0·0134* 0·0334								
* *i.e.*, Metal, 0·0061; Paper, 0·0073.								
B. Loose packet—Bronze-tipped, sent by Dr. Buchanan, Liverpool.	(*a*) Paper	21 May 1903	3·0 grms.	Basic method (as above)	0·001	$\frac{1}{200}$	0·7	Half the extract was Marshed.
Tips. Uncovered Paper.								
Lengths (cms.) 1·25 5·75	(*b*) Tips (including the paper under the metal).	21 May 1903	0·5 grm.	Chlorate method	0·029	4	370·0	One-tenth of the extract was Marshed.
Weights (grms.) 0·0119* 0·0333								
* *i.e.*, Metal, 0·0047; Paper, 0·0072.								
C. Aluminium-tipped, made and sold by a firm in the East of London.	(*a*) Paper	22 May 1903	3·0 grms.	Basic method	None.	Arsenic-free	—	Half of extract Marshed.
Tips. Uncovered Paper.								
Lengths (cms.) 0·9 6·3	(*b*) Tips (including the paper under the metal).	21 May 1903	1·0 grm.	Chlorate method (followed, as usual, by precipitation with sulphuretted hydrogen).	None.	Arsenic-free	—	Half of extract Marshed.
Weights (grms.) 0·0057* 0·0312								
i.e. Metal, 0·0012; Paper, 0·0045.								

D. Imitation gold-tipped, made and sold by a firm in the East of London. Tips. Uncovered Paper. Lengths (cms.) 1·3 5·7 Weights (grms.) 0·0144* 0·0380 *i.e.*, Metal, 0·0057; Paper, 0·0087.	(*a*) Paper	21 May 1903	3·0 grms.	Basic method	None, or negligible trace.	Mere trace, or arsenic-free.	say 0·1	Seven-tenths of extract Marshed.
	(*b*) Tips (including the paper under the metal).	21 May 1903	0·5 grm.	Chlorate method	0·015	$\frac{1}{2}$	75·0	Two-fifths of extract Marshed.
E. Loose packet, gold-tipped, sent by Dr. Buchanan, Liverpool, 23rd May 1901. Marked 306, a. Tips. Uncovered Paper. Lengths (cms.) 1·6 7·3 Weights (grms.) 0·0171* 0·0526 * *i.e.*, Metal, 0·0056; Paper, 0·0115.	(*a*) Paper	22 May 1903	3·0 grms.	Basic method	0·0015	$\frac{1}{200}$	0·7	Seven-tenths of extract Marshed.
	(*b*) Tips (including the paper under the metal).	21 May 1903	0·5 grm.	Chlorate method	0·009	$\frac{3}{5}$	90·0	One-fifth of extract Marshed.
PARCHMENT PAPER, manufactured with sulphuric acid, used for wrapping foods.	—	3 Dec. 1901	3·5 grms.	Reinsch's method	—	Arsenic-free.	—	Copper was only just stained after three hours, and in a blank with pure acid there was a similar stain after two and a-half hours.
SULPHURIC ACID from vitriol works, reported as good average makes, 1903:								
A. Not de-arsenicated. As being sold from stock (sp. gr. 1·71).		28 July 1903	0·005 c.c. (=0·0085 grms.)	Direct Marshing	0·013	$10\frac{1}{2}$	1520·0	—
B. As running from dearsenicating apparatus (sp. gr. 1·54).		28 July 1903	5 c.c. (=7·70 grms.)	ditto	None	Arsenic-free.	—	—
WATER-SOFTENING POWDER, recommended for softening domestic and drinking water		7 August 1903	2·5 grms.	ditto	0·0009	$\frac{1}{40}$	3·6	—

Notes.—The ungilded portions of a single cigarette paper of series A., B., and E. in each instance contained about one three-millionth of a grain of arsenic.

The metal of the gilded portion of a single cigarette paper contained:—Series A. $\frac{1}{25,000}$; Series B. $\frac{1}{10,000}$; Series E. $\frac{1}{20,000}$th grain of arsenic.

In all the above cases the gilt was loosely adherent to the paper, and became partly detached with only gentle rubbing, and would thus be liable to come off on the lips.

GEORGE MCGOWAN.

Appendix 26.

APPENDIX 26.

COPIES OF LETTERS FROM MR. J. N. BEACH, SECRETARY TO THE MALTINE COMPANY (*See* Q. 11,496).

8, Delahay Street,
Westminster, S.W.,
Dear Sir, 6th November, 1902.

I am directed by Lord Kelvin to inform you that this Commission wish to obtain information as to the liability of malt made in America and used for maltine and similar foods to contain arsenic, and as to the precautions against arsenic which may be taken by manufacturers of these foods in America.

Mr. Hammond Smith informs the Commission that he brought this matter to your notice last year, and that no doubt you would now be in a position to give the Commission the information they desire.

Accordingly I am directed to request that you will be so good as to attend at their next meeting on Friday, 21st instant, at 11.45 a.m. for the purpose of giving them brief evidence on the matter.

I should add that the Commission do not propose in connection with this branch of their inquiry to admit Press reporters.

I am, dear Sir,
Yours faithfully,
(Signed) G. S. Buchanan,
Secretary to Commission.

J. N. Beach, Esq.

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24 and 25, Hart Street,
Bloomsbury, W.C.,
Dear Sir, 10th November, 1902.

I have duly received your letter of the 6th instant. I remember Mr. Hammond Smith calling upon me, and he asked me to obtain from our friends in America, who manufacture a preparation called "Liquid Peptonoids," a statement as to the acid they use in their manufacturing process. Our friends wrote us, under date February 13th, 1902, as follows:—

> "Inasmuch as we use only chemically pure hydrochloric acid, in the preparation of the peptones, the presence of arsenic is out of the question."

With reference to maltine, and the precautions adopted against contamination by arsenic, in the preparation of maltine in America, my recollection is that we only discussed this generally, and I stated that I did not see how it was possible for this preparation to contain arsenic. I did not write to the Chemist of the Maltine Company on the matter. I have, however, by last mail mentioned your letter, and requested full particulars on the subject, and I think it would be well to postpone my call, until I have received an answer from our works. If you have any special points on which you want information, perhaps you will be good enough to communicate these, and I will then submit them to the other side.

Yours very truly,
J. N. Beach.

The Secretary,
The Royal Commission on Arsenical Poisoning.

8, Delahay Street, S.W.
Dear Sir, 12th November, 1902.

With reference to your letter, November 10th, I will inform the Commission at their forthcoming meeting that you are not at the moment prepared with information likely to be of service to their inquiry. As, however, they have decided that some evidence concerning maltine manufacture in America is desirable, they would be obliged if, as you suggest, you would obtain information as to liability of malt made in America and used for maltine to contain arsenic; and also as to the precautions regarding arsenic which are taken by maltine manufacturers.

I may aid that with regard to the hydrochloric acid used in "Liquid Peptonoids," &c., the Commission has received a considerable amount of evidence which shows that hydrochloric acid sold as pure may nevertheless contain notable amounts of arsenic, and I think it would be valuable to the Commission if you enabled Mr. Hammond Smith to state in somewhat greater detail in his report whether it is the custom of the manufacturers of these peptones to systematically test the acid for arsenic themselves, or what other steps are taken to secure its purity as regards arsenic.

I am,
Yours faithfully,
G. S. Buchanan,
Secretary to the Commission.

J. N. Beach, Esq.

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24 and 25, Hart Street,
Bloomsbury, W.C.,
Dear Sir, 19th November, 1902.

I duly received your favour of the 12th instant, and I have written to our friends in America for the information you desire, and will submit this to you when it comes to hand.

Yours truly,
J. N. Beach.

The Secretary,
The Royal Commission on Arsenical Poisoning.

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24 and 25 Hart Street,
Bloomsbury, W.C.,
Dear Sir, 24th December, 1902.

Referring to our letter of November 19th, our friends in Brooklyn write with reference to malt under date December 9th as follows:—

> "The liability of malt to arsenic contamination is very, very remote. Neither our maltsters nor our chemist can conceive how such contamination could occur. The extreme care and cleanliness which are observed both in the malting process and in that of the manufacture of maltine preclude contamination of any kind."

With reference to the Liquid Peptonoids, the Arlington Chemical Company write us under date 2nd instant:

> "Replying to yours of the 14th ultimo, in regard to the possibility of the presence of arsenic in the hydrochloric acid used in connection with Liquid Peptonoids, we will say that from every lot of this acid purchased by us we take a sample and submit same to tests for arsenic or other impurities, and if there is any question as to the presence of this substance we discard the lot. It is, therefore, quite impossible that there should be any contamination of Liquid Peptonoids with arsenic."

You might communicate this information to the Commission; I could not add anything to these statements if I appeared personally.

I am,
Yours respectfully,
J. N. Beach.

The Secretary,
The Royal Commission on Arsenical Poisoning.

APPENDIX 27.

LETTER FROM MR. OTTO HEHNER ON ARSENICAL CONTAMINATION OF CERTAIN FOODS THROUGH THE USE OF COLOURING MATTERS (MINERAL AND OTHER).

The Laboratory, 11, Billiter Square, E.C., London.
June 26th, 1903.

DEAR SIR,

When I had the honour, some time ago, to give evidence before the Royal Commission on Arsenical Poisoning, I drew attention to the fact that oxide of iron was frequently used as a colouring substance of articles of food, and that commercial oxide was almost invariably strongly arsenical. I had, however, at that time not been able to trace any arsenic in any articles of food thus coloured, partly owing to the comparatively small quantity of oxide used in most cases, and partly to the then difficulty of dealing with articles of food analytically, the huge relative amounts of organic matter rendering direct testing almost impossible. The process of destroying the organic matter by means of nitric and sulphuric acids and extracting the carbon with water, recommended by the Joint Committee of the Societies of Chemical Industry and Public Analysts, is so easy to carry out, and gives within a very short time trustworthy results, that I have now examined a number of food samples in which I had found added iron oxide. The results of my tests—that is to say, the tubes containing the arsenic-mirrors—I now beg to submit, through you, to the Members of the Royal Commission. They show clearly that whenever oxide of iron is used as a colour, arsenic can be traced in the food thus contaminated.

Card I. holds four mirrors consecutively obtained from the solution yielded (after acid treatment) by 10 grammes of certain sweets, of which I also enclose a sample. The arsenic is contained only in the chocolate-coloured portion of the sweets, the colour being mainly iron oxide, while the pink portion is quite free from arsenic, as shown by the tubes on card No. II. I may say that these sweets were submitted to me in my capacity as Public Analyst for the Isle of Wight, and that I have declared them to be arsenical. Whether proceedings against the vendors are being taken I cannot at the time of writing state. I estimate the sweets to contain approximately ·028 grain of arsenic per lb.

Card III. holds tubes obtained from chocolate powder lately largely sold in London at a very cheap price. The firm selling the same immediately withdrew it from the market on being informed by me of the impurity. I estimate the chocolate powder to contain approximately between ·04 and ·05 grain of arsenic per lb. They submitted to me samples of the iron oxide, which were immensely arsenical.

Cards IV., V., and VI. hold tubes showing the arsenic in some brands of bloater-paste and anchovy-paste, purchased by me in the open market. The arsenic in these samples is obviously to be easily detected by the method employed.

Although arsenic is no longer used in the manufacture of aniline colours, yet some aniline colours largely used in the manufacture of sweets and jams are strongly arsenical, probably from the use of arsenical sulphuric acid. Such colours, when tested without destruction of the organic matter, give no arsenic reaction, but readily do so after heating with nitric and sulphuric acids. Evidently the arsenic is present in organic combination, not as "ionic" arsenic. Cards VII. and VIII. show the arsenic contents of stated quantities of colour.

Lastly, Card IX. shows the arsenic from different samples of paper shavings, used to pack cakes and other similar goods.

Although it is probable that arsenic when combined with iron oxide will exert less action, if any, upon the organism than the arsenious acid, it appears to me to be a matter of grave public danger, imperilling possibly the freedom or lives of innocent persons, to permit even what may be assumed to be physiologically inert arsenic to be present in food-materials. The evidence I am submitting herewith shows clearly that through even the small proportion of colouring matter used very heavy traces of arsenic can be conveyed into food.

I have the honour to remain,
Yours very faithfully,
OTTO HEHNER.

Dr. G. S. Buchanan,
8, Delahay Street, Westminster, S.W.

P.S.—If the Royal Commission desire to see me on the matter, I am, of course, at their entire disposal.

Appendix 28.

APPENDIX 28.

POSSIBLE ADDITION OF MINERAL ACID TO WHISKY AND GIN.

I. Dr. McGowan's Report on Examination of Samples of Whisky and Gin obtained from Twelve Public-houses in the East End of London.

At the end of November, 1902, Mr. Swinson, Inspector of the London County Council, obtained samples of cheap whisky and gin from twelve public-houses in poor neighbourhoods in Poplar, Wapping, Shadwell, and St. George's in the East. In each instance he sent a labouring man into the public-house to purchase the sample. Dr. McGowan's report on these samples is as follows:—

Results of Examination of Spirits for Mineral Acid.

These were received from Dr. Buchanan on February 5th, 1903.

Date of Collection.	Description of Sample.	Chloride.	Sulphate.	Acidity calculated as Acetic acid. (1) Grains per gall.	Acidity calculated as Acetic acid. (2) Per cent.
No. 1. Nov. 21st, 1902	Whisky from "The Old Star," Watts Street, Old Gravel Lane, Wapping.	Faint trace	None.	–	–
No. 2. ,,	Whisky from "The Red Lion," Old Gravel Lane, Wapping.	Faint trace	Faint trace.	–	–
No. 3. ,,	Gin from "The Bunch of Grapes," St. George Street, Wapping.	None	None	3·75	0·054
No. 4. ,,	Whisky from "The Royal Crown," St. George Street, Wapping.	Faint trace	Trace	2·81	0·040
No. 5. ,,	Gin from "The Albion," High Street, Shadwell.	–	Trace	2·35	0·034
No. 6. ,,	Whisky from "The Duke of York," High Street, Shadwell.	None	None	1·88	0·027
No. 7. Nov. 27th, 1902	Whisky from "The Queen's Head," High Street, Poplar.	None	None.	–	–
No. 8. ,,	Gin from "The East India Arms," High Street, Poplar.	–	Trace	1·65	0·024
No. 9. ,,	Whisky from "The Old Commodore," High Street, Poplar.	Trace	None.	–	–
No. 10. ,,	Gin from "St. Leonard's Distillery," P.H., St. Leonard's Road, Poplar.	–	Trace	2·62	0·037
No. 11. Dec. 4th, 1902	Whisky from "The Jolly Sailors," St. George Street, E.	Very faint trace.	None	3·75	0·054
No. 12. ,,	Whisky from "The Red Lion," St. George Street, E.	Faint trace	Heavy trace	2·35	0·034

Note.—The above estimations were done by Mr. Eric H. Richards, B.Sc.

George McGowan.

Ealing, March 9th, 1903.

Methods.

Qualitative Tests for Sulphuric and Hydrochloric Acids.—The samples were first tested qualitatively for sulphuric acid and hydrochloric acid, either combined or free. In testing for sulphate, 5 cc. (approx.) of the spirit were diluted to about 25 cc. with water and 1 cc. of a 10 per cent. barium chloride solution was added. The liquid was boiled and any precipitate or turbidity noted. In no case was there more than a distinct turbidity, this indicating that if any sulphate was present, it was in very small amount only.

In testing for chloride with silver nitrate solution, the organic matter present in the samples of gin was found to reduce the silver salt and thus to interfere with the test. In order, therefore, to make sure that no free hydrochloric acid was present in these samples, they were all examined by the quantitative method described below. The above qualitative tests do not, of course, distinguish between free and combined acid, but the results showed that the former, if present at all, must be so in only minute and inappreciable amount. All the samples were acid in reaction when tested with phenol-phthalein, and this indicator was used in determining their acidity by titration with standard soda solution.

Detection and Quantitative Estimation of Free Mineral Acid.—The method employed to detect and estimate free mineral acid quantitatively was that described by O. Hehner ("Analyst," I. 105) for the estimation of mineral acids in vinegar. A measured volume of the spirit, usually 100 cc. was titrated with decinormal soda solution,* using phenol-phthalein as indicator.

* This solution was prepared by dissolving sodium hydroxide in absolute alcohol, in order to remove sodium carbonate, which remained undissolved.

The neutralised spirit was then evaporated to dryness on a water bath, preferably in a platinum basin. When dry, the residue was gently ignited, so as to convert any alkaline acetates, tartrates, etc., into carbonate. The ignited residue, after digesting with a little water, was then re-titrated with standard sulphuric acid. If no free mineral acid was present originally in the spirit, the amount of standard acid now required should be exactly equivalent to the alkali originally added. If, on the other hand, less acid than this was required, it followed that some of the acid neutralised by the soda must have been mineral acid, the sodium salt of which was consequently not converted into carbonate on ignition. It was not thought worth while to make this quantitative estimation with Nos. 1, 2, 7 and 9, seeing that they showed qualitatively either no chloride or sulphate, or only mere traces of these. No mineral acid was found in any of the samples tested by the above ignition process. Appendix 28.

GEORGE McGOWAN.

Ealing, March 9th, 1903.

II. INFORMATION SUPPLIED TO THE COMMISSION BY THE LONDON COUNTY COUNCIL.

County Hall, Spring Gardens, S.W.
6th March, 1903.

Sir,—I am directed to forward, for the information of the Royal Commission on Arsenical Poisoning, the enclosed statement showing the effect of the replies received from Metropolitan Borough Councils to the letter which I addressed to them by direction of the Council, suggesting that samples of whisky and gin should be analysed with a view to the detection of arsenic. It will be observed that the replies show that only negative results have been obtained.

I am Sir,
Your obedient Servant,
G. L. GOMME,
Clerk of the Council.

The Secretary,
Royal Commission on Arsenical Poisoning,
8, Delahay Street,
Westminster, S.W.

[*See Table on the following page*:—

Appendix 28.

EXAMINATION OF SAMPLES OF SPIRITS FOR TRACES OF ARSENIC.

Metropolitan Borough.	Number of Samples Analysed.	Results of Analyses.
Battersea	—	Only negative results.
Bermondsey	—	Negative results.
Bethnal Green	24	Free from any trace of arsenic.
Camberwell	—	No adulterated samples found.
Finsbury	35	No arsenic found.
Fulham	—	No result shown by the analysis.
Greenwich	—	No arsenic found.
Hackney	—	No arsenic detected.
Hammersmith	27	No evidence of sulphuric acid having been used in their preparation.
Hampstead	6	Found pure.
Holborn	—	No evidence of the presence of sulphuric acid.
Islington	10	Negative results.
Kensington	—	Negative results invariably obtained.
Lewisham	15	No arsenic detected.
Paddington	—	Not the slightest trace of arsenic.
Poplar	5	No arsenic found.
St. Marylebone	—	Negative results.
St. Pancras	—	No traces of arsenic.
Shoreditch	18	All found to be free from arsenic.
Stoke Newington	—	Entirely negative results.
Wandsworth	—	Free from injurious ingredients.
Westminster	135 (Spirits and Beer).	No arsenic detected.
Woolwich	6	All free from arsenic.

No replies have yet been received from the Chelsea, Lambeth*, Southwark and Stepney Borough Councils, and the Deptford Borough Council did not see their way to take action in the matter.

* In May 1903 the Clerk to the London County Council forwarded a letter from Dr. T. Priestly on the results of examination of 31 samples of whisky taken in the borough of Lambeth. None of these contained arsenic or free sulphuric acid.

APPENDIX 29.

REPORTS ON EXAMINATION OF ENAMELLED COOKING UTENSILS FOR ARSENIC.

Section I.—General Account and Summary of Results.

The question of the use of arsenic as an ingredient of the white enamel of saucepans, dishes, and other "hollow ware" was referred to by Mr. Hammond Smith in Section IV. of his report to the Commission (Appendix No. 24, Section IV.). In his evidence (Q. 11,008-11,023) he stated that inquiries as to the manufacture of hollow ware in this country indicated that the use of arsenic in their enamelling had been altogether discontinued in recent years. He drew attention, however, to a recent instance reported by Mr. Albert Smith, analytical chemist, of Highbury, and communicated to the "Ironmonger" of August 2, 1902 (p. 185), where up to 2·03 per cent. of arsenic was found in the enamel of certain cooking utensils. Mr. Albert Smith had also stated that he had found that solutions of common salt or soda readily took up arsenic when boiled for a few minutes in these utensils.

The Commission considered it advisable that some samples of enamelled cooking utensils should be collected and tested by Dr. McGowan in order to ascertain whether arsenical specimens such as those met with by Mr. Albert Smith were common.

Collection of Samples.

At the date of his evidence Mr. Hammond Smith had already obtained, through Mr. Cochrane, a retired ironmonger, a collection of enamelled stewpans, frying pans, and pie-dishes from nine different sources, as follows:—

Manufacturer.

Series I. Dunty and Co., Homberger Co.
,, II. Hupfeld and Co., London.
,, III. Fearncombe and Co., Wolverhampton.
,, IV. Wm. Robinson and Co., Wolverhampton.
,, V. Orme, Evans and Co., Wolverhampton.
,, VI. Charles J. Price and Sons, London.
,, VII. Hermann Wappermann, Holstein.
,, VIII. W. A. Bayliss, Cardiff.
,, IX. Anglo-American Co.

Mr. Cochrane stated that he considered that the above list comprised nearly all the principal manufacturers of enamelled cooking utensils which are sold in this country. Unfortunately, Mr. Albert Smith was unable to give any information which allowed the samples in which arsenic was present to be identified with any firm of manufacturers. He had purchased them in a street in Shoreditch from an itinerant vendor, and they had no distinctive marks. He had been informed that probably they were of Belgian make, but this was only surmise.

It seemed advisable, therefore, to add to the above series samples of cheap enamelled hollow-ware, of foreign origin, taken from small shops or street barrows. Mr. Shirley Murphy, Medical Officer of Health of the London County Council, kindly gave his assistance in the matter, and Mr. Swinson, one of the Council's inspectors, purchased such samples for the Commission. Mr. Swinson, in addition, made careful inquiries, and ascertained in several instances the place of manufacture of the specimens purchased. At the beginning of December, 1902, he had supplied the Commission with specimens as follows:—

Series.	Date of Purchase, 1902.	Vendor.	Origin of Ware if traced.
X.	18 Nov.	M. B., Commercial Road.	German Enamel Ware Company.
XI.	21 Nov.	Bought in Wentworth Street.	Said to be "German ware," but origin unknown.
XII.	20 Nov.	R. W., Soho	German ware (taken from crate).
XIII.	20 Nov.	Ditto	Belgian ware, from St. Servair (taken from crate).
XIV.	27 Nov.	S. S., Earl's Court.	Birmingham ware.
XV.	29 Nov.	L. M., Shoreditch.	Belgian ware.
XVI.	4 Dec.	G. C., Spitalfields.	Said to be German, but origin unknown.
XVII.	4 Dec.	H. K., Whitechapel.	Ditto.
XVIII.	4 Dec.	?	? Belgian ware
XIX.	4 Dec.	?	? German ware.

In transmitting these samples, Mr. Swinson sent the following note:—

"31, Whitehall Gardens,
"Gunnersbury, W.
"12th January, 1903.

"Dear Sir,

"In connection with the samples of enamel ware obtained by me, the following particulars may be of interest to you.

"The cheapest ware sold in London is apparently that of German origin, and it is ware of this make which forms the principal stock-in-trade of street-hawkers, the majority of whom are found in East London.

"These hawkers also have a quantity of Belgian ware of the quality known as 'Thirds,' as well as ware which, owing to being damaged, is unsaleable in better class neighbourhoods.

"The larger portion of the ware sold in good class shops is of Belgian make, of the quality known as 'Firsts' and 'Seconds.' Most shops of this description also stock ware of English manufacture.

"The difference in the quality of 'Firsts,' 'Seconds, and 'Thirds' is due to the number of coats of enamel placed upon the utensils. 'Thirds' are 40 per cent. to 50 per cent. cheaper than 'Firsts.'

"Ware of English manufacture is approximately 12½ to 20 per cent. dearer than Belgian ware of the quality known as 'Firsts.'

"It would appear to be impossible to distinguish between ware of Belgian and German manufacture, on which point the opinion of dealers, both wholesale and retail, is unanimous.

"This difficulty does not arise in connection with ware of English manufacture, as owing to its superior finish the latter is easily recognisable.

"The above-mentioned information was derived from various wholesale and retail hardware dealers, and I believe it can be relied on.

"Yours obediently,
(Signed) "E. Thomas Swinson."

H. Hammond Smith, Esq.

Appendix 29.

Mr. Swinson usually took more than one article in each series, and the total collection comprised a large number of saucepans, frying-pans, pie-dishes, jugs and kettles. Series XIV. consisted of only one sample—an enamelled double saucepan used for sterilising milk for infants.

The whole of the utensils of Series I. to XIX. were sent to Dr. McGowan, it being arranged that examination for arsenic would in the first instance be restricted to one or two specimens, preferably saucepans, in each series; if solutions boiled in any one saucepan showed notable amounts of arsenic then the other specimens of that series were to be tested.

Solubility of Arsenic when an Ingredient of Enamel.

Before proceeding on this work, however, Dr. McGowan considered it desirable to ascertain whether a saucepan with arsenic in its enamel will yield a material quantity of arsenic when boiled with plain water, or whether for the purpose required it would be more satisfactory to use a boiling solution of common salt, or a boiling solution made alkaline by carbonate of soda. For this purpose Mr. Hammond Smith communicated with a firm in the Midlands, who, after study of the analyses made by Mr. Albert Smith, kindly undertook to prepare experimental saucepans of the kind required. They made four saucepans, A^1, A^2, B_1, and B_2, as follows:—

In A^1 and A^2 the enamel consisted of a ground glass to which lead carbonate and arsenic were added in the mill as follows:—

Anhydrous plumbic carbonate, 5 lbs.
Arsenious anhydride, 6 ozs.
To a 25 lb. charge of the glass.

In B_1 and B_2 the enamel consisted of a similar glass, to which were added in the mill:—

Anhydrous plumbic carbonate, 5 lbs.
Arsenious anhydride, 8 ozs.
Magnesic carbonate, 4 ozs.
To a 25 lb. charge of the glass.

Each saucepan had two coats of arsenical enamel laid on a first coat which contained no arsenic. Each was a six pint saucepan, and the weight of the arsenical enamel used was roughly estimated at 6 ozs. in each case.

The results of testing solutions boiled in these saucepans are reported in Section II. below. It was found that a considerable quantity of arsenic was extracted from the enamel by boiling with London tap water, and still more by boiling with soft, glass-distilled, water. After such boiling the quantity of additional arsenic which was extracted by a further boiling with a saline or slightly alkaline solution was relatively small. Taking the highest result, the amount of arsenic extracted from saucepan A^1, namely, 1-14th grain, was obtained by a single boiling with distilled water. It seemed sufficient, therefore, in the first instance to boil glass distilled water in each of the purchased specimens which were to be examined. If arsenic was detected in noteworthy amount in any particular instance, further experiments could be made with saline and alkaline solutions.

Examination of Series of Enamelled Cooking Pots I. *to* XIX.

The results of examination in this way of specimens of hollow ware from Series I. to XIX. are given by Dr. McGowan in Section III. Prolonged boiling with glass-distilled water did not in any instance extract more than a trace of arsenic so small as to be almost incapable of estimation. In no instance would the proportion of arsenic extracted represent more than ·005 per million, calculated approximately on the original volume of liquid taken. It was safe to conclude from these results that arsenic had not been purposely added as an ingredient of the enamel in any of the specimens examined. There was nothing to suggest that examination of all the specimens in any one series was specially called for, and accordingly the surplus samples obtained have not been tested. G. S. B.

June, 1903.

SECTION II.—REPORT BY DR G. McGOWAN ON THE EXAMINATION OF SOLUTIONS BOILED IN SPECIALLY MADE SAUCEPANS, THE ENAMEL OF WHICH CONTAINED ARSENIC AS AN INGREDIENT.

The four saucepans in question were received in December, 1902. Their origin and composition have been described in Section I. Their capacity in each instance was about six pints or 3½ litres. As filled up with water to be boiled, they contained something like five pints, or 2¾ litres.

The method followed was to fill the pot nearly full with either glass-distilled water or other liquid, and to boil vigorously at first, and then more gently as the volume of liquid became smaller. The boiling down usually required from four to five hours. When the volume had been reduced to about 300 c.c. or so, the liquid was transferred to a basin of Berlin porcelain, evaporated down to a small bulk and made up to 100 c.c. A suitable portion was then Marshed with hydrochloric acid (hydrochloric acid standards being used).

The residual solutions were always more or less turbid, especially, of course, when tap water was used. In every case there was a small quantity of sediment which could not be washed out of the saucepans, and which it was not considered advisable to rub off, for fear of detaching other matter at the same time.

The saucepans were cleaned between two operations by running some water into them and rubbing with an ordinary saucepan brush.

It will be seen that the above conditions of experiment were not actually the same as those which obtain in cooking (the saucepans having no lids). Less surface was exposed to the water in the experiment, because the volume of the liquid gradually diminished; but, on the other hand, the long time during which boiling proceeded would tend to equalise this.

The results obtained are shown in Table I. below.

SECTION III.—REPORT BY DR. McGOWAN ON EXAMINATION FOR ARSENIC OF ENAMELLED COOKING UTENSILS (SERIES I. TO XIX.) OBTAINED FROM VARIOUS SOURCES.

The method of examination here again consisted in each instance in boiling down glass-distilled water from one hour to four hours, according to the size and shape of the vessel, and Marshing as described in the last section.

The results obtained are shown in Table II. below.

June, 1903. G. McGOWAN.

TABLE I.

SPECIALLY MADE SAUCEPANS IN WHICH ARSENIC WAS AN INGREDIENT OF THE ENAMEL.

Vessel Employed	Total Capacity and Shape.	Date of Experiment.	Solution Boiled.	Time Required for Boiling Down.	Mirror read: Milligrams As_4O_6.	Total Quantity of Arsenic Extracted in the Boiling, in Grains.	NOTES.
Saucepan A_1	Depth, 13 c.m. (5·12 inches). Diameter, 17·1 c.m. (6·75 inches). Capacity, 3·35 litres. Volume of liquid taken for boiling, about 2·75 litres.	19 December 1902	Tap water (Ealing)		0·030	$\frac{1}{43}$	2 per cent. of extract Marshed.
„ A_1	Ditto ditto	2 January 1903	Glass distilled water	4½ hours	0·023	$\frac{1}{14}$	0·5 per cent. of extract Marshed.
„ A_1	Ditto ditto	12 January 1903	Tap water containing 10 grammes common salt.		0·031	$\frac{1}{21·5}$	10 per cent. of extract Marshed.
„ A_1	Ditto ditto	30 January 1903	Glass distilled water with 0·5 grammes sodium carbonate.		0·032	$\frac{1}{52}$	2½ per cent. of extract Marshed. This was not boiled in porcelain basins. At end of evaporation the concentration of the sodium carbonate was about 1 per cent.
„ B_1	Ditto ditto	19 December 1902	Tap water		0·024	$\frac{1}{27}$	1 per cent. of extract Marshed.
„ B_1	Ditto ditto	2 January 1903	Glass distilled water	4 hours	0·029	$\frac{1}{56}$	2½ per cent. of extract Marshed.
„ B_1	Ditto ditto	12 January 1903	Tap water containing 10 grammes common salt.		0·038	$\frac{1}{171}$	10 per cent. of extract Marshed.
„ B_1	Ditto ditto	30 January 1903	Glass distilled water with 0·5 grammes sodium carbonate.		0·032	$\frac{1}{55}$	2½ per cent. of extract Marshed.
„ A_2	Enamel identical with that of A_1. Ditto ditto	5 January 1903	Glass distilled water		0·019	$\frac{1}{84}$	1 per cent. of extract Marshed.
„ A_2	Enamel identical with that of A_1. Ditto ditto	13 January 1903	Ditto ditto		0·026	$\frac{1}{373}$	15 per cent. of extract Marshed.
„ A_2	Enamel identical with that of A_1. Ditto ditto	10 February 1903	Glass distilled water with 0·5 grammes sodium carbonate.		0·018 (Not a satisfactory reading.)	$\frac{1}{93}$	2½ per cent. of extract Marshed.
„ B_2	Enamel identical with that of B_1. Ditto ditto	5 January 1903	Glass distilled water		0·034	$\frac{1}{114}$	6 per cent. of extract Marshed.
„ B_2	Enamel identical with that of B_1. Ditto ditto	13 January 1903	Ditto ditto		0·020	$\frac{1}{353}$	10 per cent. of extract Marshed.
„ B_2	Enamel identical with that of B_1. Ditto ditto	10 February 1903	Glass distilled water with 0·5 grammes sodium carbonate.		0·030	$\frac{1}{55}$	2½ per cent. of extract Marshed.

NOTES.

1. There was always some gelatinous matter—no doubt, Silica—in suspension in the extracts, and the arsenical (and also the non-arsenical) mirrors appeared to be heavier according as a larger amount of this was present. As regards arsenical mirrors, this applies only to the saucepans A_1, A_2, B_1, and B_2.

2. There was also in every case a considerable mirror upon the wrong side of the flame (Query—Antimony ?), which appeared to be more or less proportionate in density to the arsenical mirror, *i.e.*, if the amount of arsenic extracted from a saucepan was relatively large, so also was the amount of this other substance. This non-arsenical mirror was not due to carbonaceous matter. As to this see Special Experiment with Sample No. XV.B (Table II).

George McGowan.

APPENDIX No. 29—*continued.*

TABLE II.

ENAMELLED COOKING POTS OF SERIES I. TO XIX.

Vessel Employed.	Origin of Sample, Series	Approximate Total Capacity and Shape.	Date of Experiment, 1903.	Solution Boiled.	Time required for Boiling down.	Mirror read—Milligrams AS_2O_6.	Other Mirror besides the Arsenical Mirror.	Total quantity of Arsenic extracted in the boiling.	NOTES.
Small Saucepan	I.	700 c.c.	21 February	Glass-distilled water.	The time required for boiling down varied from about one hour in the case of the smallest vessels to between four and five hours in the case of the largest.	None	None	None	Whole extract Marshed.
Small Saucepan	II.	500 „	21 February	ditto	ditto	Trace	None	Trace	Whole extract Marshed.
Small Saucepan	III.	750 „	23 February	ditto	ditto	None	Fairly heavy mirror on both sides of flame.	None	Whole extract Marshed. This extract, like all others which gave non-arsenical mirrors, was distinctly turbid.
Small Saucepan	IV.	500 „	18 February	ditto	ditto	Mere trace	None	Mere trace	Whole extract Marshed.
Small Saucepan	V.	350 „	16 February	ditto	ditto	Mere trace	None	Mere trace	Whole extract Marshed.
Frying-pan	V.	500 „	20 March	ditto	ditto	0·0018	None	Merest trace	Whole extract Marshed.
Small Saucepan	VI.	750 „	23 February	ditto	ditto	None	Small	None	Whole extract Marshed.
Pie-dish	VII.	1,250 „	27 May	ditto	ditto	None	None	None	Whole extract Marshed.
Small Saucepan	VIII.	500 „	18 February	ditto	ditto	Probably a small amount which could not be estimated.	Large	(?)	Whole extract Marshed. This enamel had a bluish mottled appearance. The extract looked turbid like those from A_1, B_1, A_2 and B_2.
Small Saucepan	IX.	350 „	16 February	ditto	ditto	0·0013	None	Merest trace	Whole extract Marshed.
Coffee-pot	X.	1,000 „	14 February	ditto	ditto	None	Slight	None	⅔ths of extract Marshed.
Jug	X.	1,600 „	20 February	ditto	ditto	0·002	None	Merest trace	Whole extract Marshed.
Mug	X.	500 „	27 February	ditto	ditto	None	None	None	Whole extract Marshed. Enamelling faulty.
Bowl	X.	500 „	27 February	ditto	ditto	Mere trace	None	None	Whole extract Marshed. Enamelling faulty.

Stewpan	X.	1,750 c.c. Depth - 3·25 inches. Diameter 6·5 inches.	25 February	ditto	0·002	None	Merest trace	Whole extract Marshed
Stewpan	X.	2,500 c.c. Depth - 4¼ inches. Diameter 7 inches.	26 February	ditto	0·001	None	Merest trace	Whole extract Marshed.
Saucepan	XI.	2,750 c.c. Depth - 5·25 inches. Diameter 6·4 inches.	14 February	ditto	0·002	None	Trace (0·0001 grain).	⅓rd of extract Marshed.
Pie-dish	XII.	1,250 c.c.	27 May	ditto	Mere trace	None	None	Whole extract Marshed.
Pie-dish	XIII.	1,250 „	27 May	ditto	0·001	Distinct	None	Whole extract Marshed.
Milk Sterilizer:	XIV.							
(a.) Inside portion	—		16 February	ditto	Trace	None	None	Whole extract Marshed.
(b.) Outside portion	—		16 February	ditto	Mere trace	None	None	Whole extract Marshed.
Small Saucepan	XV.	1,000 c.c. Depth - 3·0 inches. Diameter 5·5 inches.	26 February	ditto	0·001	None	Merest trace	Whole extract Marshed.
Stewpan	XV.	3,000 c.c. Depth - 4½ inches. Diameter 8 inches.	17 March	ditto	Very little, but could not be read with any accuracy in either of two estimations.	Large	(?)	Whole extract Marshed in both cases.
Porridge-pot:	XVI.							
(a.) Inside vessel	—	2,000 c.c. Depth - 5·25 inches. Diameter 5·75 inches.	24 February	ditto	None, so far as could be judged.	Mirror on wrong side.	(?)	Whole extract Marshed.
(b.) Outside vessel	—	3,500 c.c. Depth - 5·75 inches. Diameter 6·75 inches.	17 March	ditto	Trace	None	Trace	Whole extract Marshed. Enamel not perfect. Small patches of metal exposed.
Teapot	XVII.	1,000 c.c.	27 May	ditto	0·001	None	Merest trace	Whole extract Marshed.
Stewpan	XVIII.	1,500 „	25 February	ditto	Merest trace	None	Merest trace	Whole extract Marshed. Enamel not quite perfect around the bottom.
Stewpan	XIX.	1,000 „ Depth - 3·75 inches. Diameter 4·75 inches.	14 February	ditto	Merest trace	None	Merest trace	⅓rd of extract Marshed.

NOTES.

1. NOTE TO STEWPAN OF SERIES XV.—A third quantity of glass-distilled water was evaporated in Stewpan No. XV.B, the residual liquid digested in a porcelain basin with hydrochloric acid and chlorate of potassium, reduced with sulphurous acid in the usual way and Marshed. The mirror obtained was almost identical with those in the first two estimations (which were Marshed directly). This proves that the mirror was not due to organic matter.

2. In certain instances I have worked out the approximate quantity of arsenic in parts per million of the solution, calculated approximately on the original volume of liquid taken for boiling. The highest proportion thus calculated is no more than 0·004 part of arsenic per million (SAUCEPAN OF SERIES IX.).

George McGowan.

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APPENDIX 30.

REPORTS ON MALTING ANTHRACITE.

REPORTS ON INVESTIGATIONS MADE FOR THE COMMISSION ON MALTING ANTHRACITE, AND "IMPURITIES" IN ANTHRACITE SEAMS, IN THEIR RELATION TO ARSENIC.

The Reports on this subject are arranged in parts as follows :—

I. Account of Inquiry and Summary of Results.

II. Notes by Mr. H. Hammond Smith on inquiries as to anthracite used at certain maltings visited by him in August, 1901.

III. Notes by Mr. A. Strahan, F.R.S., District Geologist of H.M. Geological Survey, on visits made by him to certain anthracite collieries in South Wales which supply maltsters, and recommendations as to samples which should be collected for analysis.

IV. Report by Mr. S. Warren Price, Lecturer on Mining Engineering at University College, Cardiff, on his collection of specimens for the Commission at these anthracite collieries in South Wales, together with notes on observations made by him in course of sampling in the mines.

V. Report by Dr. G. McGowan on the results of examination for arsenic of the specimens obtained by Mr. Price at anthracite collieries in South Wales, and also on a few other samples of malting fuel.

N.B.—A memorandum by Dr. McGowan and Mr. R. B. Floris on the methods adopted in estimating arsenic in fuel samples appears in a separate Appendix No. 23.

VI. Account of two experiments at Newark maltings.

PART I.—ACCOUNT OF INQUIRY AND SUMMARY OF RESULTS.

ACCOUNT OF INQUIRY.

At the outset of the inquiry it was desired to obtain information as to the collieries which supplied some representative maltsters, and as to the custom of maltsters in selecting and ordering their fuel.

Mr. Hammond Smith's Notes.

In these notes (*No. II., below*) Mr. Hammond Smith reports on visits made in August, 1901, to four large malting firms at Newark, Burton, Sawbridgeworth and Smethwick respectively. All these firms had used anthracite exclusively since attention was directed to the liability of malt to contain arsenic ; two had formerly used coke. Their anthracite was obtained directly or through agents from nine collieries altogether, eight of which were identified by Mr. Smith. He gives notes of the considerations (heating power, "flavouring" properties, etc.) which appeared to influence the maltsters in the selection of particular collieries. All anthracite supplied was understood to be hand-picked at the colliery in order to remove impurities, but impure coal and pyrites were sometimes met with in the fuel delivered. Two maltsters had caused some analyses of anthracite for arsenic to be made, but there had been no question at any of the maltings of purchasing anthracite under guarantee as to arsenic. No weight was attached by the maltsters to copies of analyses which they received from colliery companies showing that anthracite samples had been found free from arsenic.

Mr. Strahan's Notes.

Following on communications between the Commission and the Geological Survey, Mr. A. Strahan, District Geologist of the Survey, arranged to make inquiries in the directions desired by the Commission at a series of anthracite collieries in South Wales.

The collieries which Mr. Strahan selected for inquiry were the eight which Mr. Hammond Smith had ascertained to supply the malting firms visited, and three others which Mr. Strahan afterwards ascertained to supply malting anthracite. In one case the manager of the colliery, who had heard that inquiries were in progress, requested that his colliery should be visited. In other instances the secretary or manager of each colliery was advised of Mr. Strahan's proposed visit, and in every case facilities for the inquiry were readily afforded.

The great bulk of the anthracite used by English maltsters is derived from a limited portion of the South Wales coalfield, a strip of country some 25 miles by 4, which Mr. Strahan describes. Ten of the collieries which he visited are situated in various parts of this area, and they may be regarded as fairly representative of the whole of this anthracite field. A single colliery which is outside the main coalfield was also visited. The facts as to this colliery are separately dealt with in these notes.

After visiting these collieries Mr. Strahan drew up a Memorandum for the Commission (*No. III., below*), in which he set out the results of inquiries made at each colliery on the following points :—

What seams of anthracite were worked.

Whether malting anthracite was obtained solely from a particular seam or seams ; if from more than one, whether it was the custom to consign mixed fuel to maltsters.

Whether visible pyrites (either as "brasses" or as "black pyrites") occurred in the malting seams ; if so, whether it was present in lumps or in bands, whether it was restricted to the upper or lower parts of the seams, and how far it was separable from the coal either by the miners underground, or by hand picking if it came to the surface.

Whether impurities distinguishable by eye from pure anthracite, other than pyrites, occurred in the malting seams, and if so, to what extent such impurities were also capable of exclusion at the colliery.

What was the actual practice at the colliery in removing pyrites or other visible impurities from anthracite consigned to maltsters; and whether there had been any recent alteration in this respect in consequence of demands by maltsters for arsenic-free fuel.

Besides obtaining information on these points, Mr. Strahan obtained particulars regarding the depth of the several seams or "veins" of coal at each colliery. These, along with other data, enabled him to trace particular seams of anthracite through the various collieries, and to indicate which seams appear to correspond geologically in different mines.

At certain collieries only a single seam or vein of anthracite is worked for malting; at others several seams are so worked. The greater part of the coal used for malting is obtained from one seam, viz., "that which is known in various collieries as the Stanllyd, Big, or the Nine-feet Vein." Other seams lying above or below the Stanlydd are worked at certain collieries. Including the Stanlydd there are five seams in the anthracite region from which malting coal may be derived. In Table IV. of this Appendix Mr. Strahan sets out a plan showing in order of sequence all the seams met with at the collieries visited and the names under which they appear at each colliery. The various seams "crop out and are worked near the surface as well as at great depths below it, the term "deep" which is applied to some of them in the trade having thus no significance."

Particulars corresponding to those obtained in the case of "malting" seams were also ascertained regarding other seams which were worked but which were said not to be used to supply maltsters. This made it more easy to see how far the characteristic impurities of a seam or vein in a given mine might be regarded as local, or how far, on the other hand, they appeared to accompany the seam from colliery to colliery.

On completion of his inquiries Mr. Strahan advised as to the samples which should be taken.

Mr. Price's Report.

The services of Mr. S. Warren Price, Lecturer on Mining Engineering at University College, Cardiff, were engaged by the Commission to procure the specimens. It was obviously of the first importance that the samples obtained should be properly representative and should be collected on a uniform system, and accordingly at the outset a scheme for their collection was drawn up in some detail in consultation with Mr. Strahan. At various dates between December, 1901, and August, 1902, Mr. Price visited the collieries in question. In each instance notice of the visit was given to the management of the colliery, together with a general statement of the nature of the samples which it was desired to collect.

The samples thus obtained by Mr. Price may be divided as follows:—

A.—An average sample (representing a considerable bulk) of the coal being supplied for malting purposes at each colliery, taken at the colliery from railway waggons consigned to maltsters, or from coal in course of being loaded or ready to be loaded.

B.—A sample or samples taken in the mine from each seam from which anthracite is obtained for malting purposes; every such sample adequately representing the whole thickness of the seam, and excluding bands of shale, pyrites, or other impurities (if present) which can be, and customarily are, picked out either in the mine or at the surface.

C.—Special samples, consisting (a) of the above impurities which can be, and customarily are, rejected, and (b) where desired, of seams not used for malting, analysis of which was desirable for purposes of comparison.

The samples (which in the case of each of the coal specimens were usually about 20 lbs. in weight) were labelled and packed in wooden boxes.

After completion of his visits to the collieries Mr. Price prepared a report (*No. IV. below*) detailing his proceedings in collecting the samples, and also giving some notes of his own observations at the collieries.

Dr. McGowan's Report.

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Dr. McGowan found that it was necessary to undertake a considerable amount of experimental work in his laboratory before deciding upon a satisfactory method of estimating the proportions of "total," "fixed," and "volatile" arsenic in these various fuel specimens, one of the principal difficulties which had to be met being the necessity of eliminating salts of iron from solutions added to the Marsh apparatus. In a separate Appendix, No. 23, he has set out (conjointly with Mr. Floris) the methods which were finally adopted, and which were applied to all the fuel samples submitted to him.

Supplementary samples, 1903.

In March, 1903, the results of the examination of the malting coals and samples of anthracite from the mines were nearly all available. On comparison it seemed desirable that a few further samples should be obtained. This was done by Mr. Price in April, 1903.

In 1903 also a few samples of coke were obtained. Four of these were Yorkshire gas coke carefully sampled from bulk at three gas-works in the neighbourhood of Halifax, each of which formerly supplied maltsters. There was some difficulty in getting to know of oven coke manufacturers who supply maltsters, as sale of this coke to maltsters is usually effected through agents. The four samples of oven coke examined came from different places of manufacture, and were carefully sampled from bulk at a Midland ironworks.

The results of analyses of these different samples have been included in the Table submitted by Dr. McGowan in his report. (*No. V. below.*)

SUMMARY OF RESULTS OBTAINED.

Much care has been taken by the writers of the several reports to set out the results of their inquiries in such a way that the facts regarding the nature and origin of each particular sample can be readily ascertained. It may however be convenient to summarise the main facts which have been brought out with regard to arsenic in anthracite obtained from South Wales.

With this object the following notes have been prepared by the Secretary of the Commission, in consultation with the writers of the reports.

A.—Tabular Statements of Results.

Table I.

Table I. is restricted to the samples of anthracite *ready for maltsters*, taken at the colliery; the bulk from which the sample was derived having been in each instance indicated by the management of the colliery.

Table II.

Table II. relates to samples taken *in the mine from the seams which are used to supply maltsters.* It sets out the results of analysis of the sample or samples representing the thickness of the seam; the nature of impurities, if any, which are present in the seam and are capable of exclusion at the colliery, and the amount of arsenic determined in specimens of such impurities.

Table III.

Table III. relates to all the seams from which anthracite is obtained at the various collieries, including several not used for malting. It consists of two parts, *A* and *B*, both arranged in the same way. *A* is Mr. Strahan's table, showing, in descending order, the seams met with at each colliery, and their apparent geological correspondence

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in the several mines. *B* shows on the same arrangement the proportions of "total arsenic" determined in the samples taken from these seams.

B.—Presence of "Impurities" in Anthracite Seams and their Removal at the Collieries.

In a given colliery a particular seam of anthracite usually has certain definite characteristics as regards the presence or absence of impurities, and the nature of the impurities present. As a rule these characteristics are fairly constant throughout the seam at any particular colliery; they not infrequently extend over a considerable area and thus are met with in the same seam in several collieries.

Some seams are "solid"; in section they show anthracite of uniform appearance without "partings," or bands, and no pyritous or other lumps are met with. From such seams (save for fragments of roof or floor which may be sent to the surface along with the coal) there are practically no impurities to be removed.

Other seams contain visible impurities of one or another kind, *e.g.*

(*a*) Definite lumps or nodules of various sizes, some consisting of yellow pyrites; others (also termed "pyrites" at the collieries) consisting of hard black masses showing no yellow pyrites.

(*b*) Granular black bands (sometimes streaked with yellow pyrites) either of definite thickness and traversing the seam at some particular level or appearing intermittently.

(*c*) Bands of impure coal often consisting largely of shale—found chiefly near the top or bottom of the seam.

(*d*) In some cases there is a parting near the top or base separating off a thickness of the vein in which the anthracite, for one or another reason, is considered "inferior," and is accordingly separated from the remaining coal in the vein.

At all the collieries where inquiry was made steps appear to be taken to remove impurities such as those just mentioned, with the object of supplying maltsters with what may be termed "clean" anthracite. The removal is effected either in the mine or by hand picking at screens on the surface, it being usual to supply the maltster with anthracite in large lumps. Removal of large masses or nodules of pyrites can easily be effected at the colliery, but in the case of granular bands closely adherent to the coal the matter is more troublesome. (See Mr. Price's Report as to Colliery H.)

Probably the greatest difficulty of all arises where the pyrites is distributed in many small black bands about the seam. Mr. Price draws attention in his report to the advantage to be derived from treating these and other coals by suitable appliances (already provided at a few collieries) which afford greater facilities for the removal of impurities.

C.—"Clean" Anthracite in Regard of Arsenic.

Anthracite from seams used for malting.

Twenty-two samples of this class were examined, each representing the whole thickness of a seam used for malting, exclusive of visible impurities, if any, which were capable of removal. They were found to contain amounts of "total" arsenic as follows:—

0–10 parts per million									0–5 parts - 7 5–10 „ - 12		19
10–20	„	„	„	-	-	-	-	-			3
20–30	„	„	„	-	-			-			0
30–40	„	„	„		-	-		-			0
Over 40	„	„	„		-		-	-			0
											22

Anthracite from seams not used for malting.

Seven samples of this class were similarly taken. Of these, six contained less than ten parts of ("total") arsenic per million, and one contained eleven parts per million.

Anthracite as consigned to maltsters.

Twelve samples of this class were taken at the ten collieries in question. Each of these samples represented a large bulk, which was indicated by the management of the colliery as satisfactory malting anthracite. They were found to contain amounts of ("total") arsenic as follows:—

0–10 parts per million									0–5 parts - 6 5–10 „ - 6		12
10–20	„	„	„	-	-	-	-	-			0
20–30	„	„	„	-	-	-	-	-			0
30–40	„	„	„	-	-	-	-	-			0
Over 40	„	„	„	-		-	-	-			0
											12

It is interesting to compare these results with the only other series of reports of analysis of anthracite samples which the Commission have received, namely that given by Mr. Ling in his evidence to the Commission in June, 1902. In making this comparison it should, however, be remembered that Mr. Ling had not at that date fully dealt with the difficulty as regards iron which Dr. McGowan found so important in analyses of fuels (Q. 10488), and that Mr. Ling's samples were supplied by maltsters, and in many cases represented a small casual collection of pieces of anthracite rather than the result of systematic sampling such as was undertaken by Mr. Price.

The amounts of "total" arsenic in Mr. Ling's samples (neglecting his four "bad" anthracites, which were either slaty or pyritous, and in the sense of these reports would constitute "impurities") were as follows:—

0–10 parts per million									0–5 parts - 8 5–10 „ - 9		17
10–20	„	„	„	-	-	-	-	-			3
20–30	„	„	„	-	-	-	-	-			1
30–40	„	„	„	-	-	-	-	-			0
Over 40	„	„	„	-	-	-	-	-			0
											21

These may be contrasted with the amounts of total arsenic found by Mr. Ling in samples of coke supplied to maltsters:—

										Gas coke.	*Oven coke.*
0–10 parts per million									0–5 parts 0 5–10 „ 5	5	*0*	*5*
10–20	„	„	„	-	-	-				3	*1*	*2*
20–30	„	„	„	-	-	-				4	*4*	*0*
30–40	„	„	„	-	-	-				0	*0*	*0*
Over 40	„	„	„		-	-				4	*0*	*4*
										16	*5*	*11*

Dr. McGowan, in 1903, analysed four samples of coke taken from a certain Yorkshire gas-works which formerly supplied maltsters, and other four samples of oven coke, taken from bulk at a Midland iron-works, with the following results as regards ("total") arsenic:—

										Gas coke.	*Oven coke.*
0–10 parts per million									0–5 parts 0 5–10 „ 2	2	*0*	*2*
10–20	„	„	„	-	-	-				1	*0*	*1*
20–30	„	„	„	-	-	-				1	*0*	*1*
30–40	„	„	„	-	-	-				1	*1*	*0*
Over 40	„	„	„	-	-	-				3	*3*	*0*
										8	*4*	*4*

Taking into consideration the number and diverse origins of the various samples of "clean" anthracite examined for the Commission and the care taken to see that they were representative, it may be concluded that the results above summarised give a fair indication of the ordinary limits within which the small amounts of arsenic found

in "clean" anthracite from South Wales collieries may vary. Some samples contain much more arsenic than others, but the variations are within much narrower limits than is the case with gas cokes or oven cokes of the kind which are, or have been, used habitually by maltsters. It is evident that some oven cokes may contain quite small proportions of arsenic, and it is likely that many gas cokes would show much less arsenic than the Yorkshire samples above referred to. But it may be concluded the clean South Wales anthracites, as a class, are much purer as regards arsenic than either of these kinds of coke.

Reference must, however, be made in this connection to the examination of samples from Colliery Q. This colliery, with a few others of small size, is situated in an anthracitic region outside the main coalfields altogether. Two thin veins of anthracite (1) and (2) are worked. Both veins are "solid"; in each the anthracite appears uniform, and is comparatively soft. They may, however, have been modified in structure by some geological disturbance to which the strata of this field have been subjected.

In 1902 Mr. Price took a sample representing the whole thickness of Seam (1) at a particular spot underground, and also a similar sample from Seam (2). Neither showed exceptional amounts of "total" arsenic, the figures being 2·57 and 7·2 parts per million respectively; but in a third sample, taken from a considerable bulk of anthracite which had been in stock at the colliery, and was said to have been derived from both seams, the surprising amount of 90 parts of "total" arsenic per million was detected. In view of this result a second sample was taken by Mr. Price in April, 1903, from a "stock pile" of anthracite at this colliery. This sample also showed a very high arsenic content—50 parts per million.

The time available for these inquiries did not admit of the extensive series of field observations and chemical analyses which would have been necessary to establish the origin of the arsenic in these samples from Colliery Q. The results differ so greatly from all the other "clean" anthracite samples that it may be assumed that they are quite exceptional. Their chief importance lies in the fact that they show that caution is needed in judging anthracite solely from its appearance. It must not be assumed that a solid anthracite, which is free from the visible impurities referred to in this Report, contains *invariably* such small proportions of arsenic as those found in the numerous samples taken in the main anthracitic region of South Wales.

D.—Impurities of Anthracite Seams in Regard of Arsenic.

(*a*) *Definite hard masses or nodules.*—As might have been expected, nodules consisting wholly or in part of yellow pyrites ("brass") contain large amounts of "total" arsenic.

Sample 24, Colliery D, 1,300 parts of "total" arsenic per million.
" 16, " B. 180 " "
" 23, " D, 93 " "

[It may be here noted that Mr. Ling's estimates of "total" arsenic in samples of "brasses" taken from anthracite at maltings were as follows (Evidence, June, 1902):

I.—1,000 parts of "total" arsenic per million.
II.—1,571 " " "
III.—107 " " "]

Hard black nodules locally termed "pyrites," but showing no yellow pyrites, met with at various collieries and always in the same (Big or Stanllyd) vein, showed comparatively small quantities of arsenic.

Sample 28, Colliery E, 10·0 parts of "total" arsenic per million.
" 32 " F, 12·0 " "
" 37, " G, 2·5 " "
" 62, " K, 3·8 " "

(*b*) *Granular black bands* ("black pyrites" mixed with variable amounts of coal) appearing intermittently or constantly at particular levels in the seams showed notable amounts of arsenic. Appendix 30.

Sample 61, Colliery K, 200·0 parts of "total" arsenic per million.
" 51, " J. 18·4 " "
" 44, " H, 15·3 " "

Some of these bands are reported as liable to contain streaks of yellow pyrites. Practically speaking, however, there was no yellow pyrites to be seen in any of the above three samples.

(*c*) *Bands of impure coal, consisting largely of shale,* in two instances out of three were highly arsenical.

Sample 15, Colliery B, 280·0 parts of "total" arsenic per million.
" 46, " H 83·0 " "
(shaly band at base of vein)
" 45, Colliery H, 6·4 " "
(thin shaly parting in middle of vein).

In sample 15 a thin layer of yellow pyrites could be detected in a few portions; neither of the other samples showed any yellow pyrites.

[It may be here noted that Mr. Ling drew attention to the large amount of arsenic found by him in three "slaty" samples of anthracite. In the single specimen of shale which he examined he found 250 parts of arsenic per million.]

(*d*) "*Inferior coal*" separated by partings from the rest of the thickness of the vein showed in most instances more arsenic than the "better" coal of the rest of the vein.

"*Inferior coal*" *at top of Big or Stanllyd Vein.*

Sample 25, Colliery D, 9·25 parts of "total" arsenic per million.
" 31, " F, 19·0 " "
" 39, " G, 23·0 " "
" 52, " J, 4·0 " "

"*Inferior coal*" *at base of Big or Stanllyd Vein.*

Sample 38, Colliery G, 19·5 parts of "total" arsenic per million.

"*Inferior coal*" *at base of Pump Quart Vein.*

Sample 7, Colliery A, 8·67 parts of "total" arsenic per million.
" 19, " C, 9·5 " "

E.—Anthracite and Impurities of Anthracite Seams in Regard of "Volatile" Arsenic.

Besides estimating the total arsenic in each sample, Dr. McGowan has in each instance reckoned the proportion of arsenic which was volatile when the anthracite was burnt under the conditions of his tests described in Appendix 23.

As regards "*clean*" *anthracite*, the proportion of "volatile" arsenic to total arsenic varied greatly in the different samples examined. Nothing like a constant ratio between the two is to be traced; samples showing much the same proportions of "total" arsenic varied greatly as regards the corresponding "volatile" arsenic, and *vice versâ*. The results may be summed up as follows:—

21 *Specimens of Anthracite from Malting Seams.*

0 –2·5	parts of "volatile" arsenic per million.	14:—"Volatile" arsenic per cent. of "total" arsenic; *average*, 23·7; *range*, from 5·6 to 57 per cent.
2·5–5	" "	6:—"Volatile" arsenic per cent. of "total" arsenic; *average*, 41·8; *range*, from 27 to 62 per cent.
5 –10	" "	0.
10 –20	" "	1:—"Volatile" arsenic 58 per cent. of the "total" arsenic

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12 *Specimens of Anthracite Consigned to Maltsters.*

0–2·5 parts of "volatile" arsenic per million	10:—"Volatile" arsenic per cent. of "total" arsenic; *average*, 28·6; *range*, from 10·4 to 48·7 per cent.
2·5–5 " "	2.—"Volatile" arsenic respectively 50 and 48·6 per cent. of "total" arsenic.

As regards *impurities* in the anthracite seams, in the "inferior coals," and also in the hard black nodules from the Stanllyd vein in various collieries, the proportions of arsenic which were "volatile" varied within a considerable range. In the case of the lumps of yellow pyrites, and also of the pyritous bands and shales met with in some collieries, Dr. McGowan draws attention to the fact that the proportion of "volatile" to "total" arsenic was generally high. Thus:—

	"Volatile" arsenic parts per million.	"Volatile" arsenic per cent. of "total" arsenic.
Three samples of yellow pyrites, occurring in lumps.	966	74·4
	110	61·1
	68	72·6
Three samples of impure coal consisting largely of shale.	211·4	75·5
	46·6	56·0
	2·1	32·9
Three samples of black pyritous band traversing a seam.	6·6	43·4
	13·2	71·7
	196·0	70·0

Significance of "Volatile" Arsenic.

The "volatile" arsenic in each of these examinations represents the difference between the estimated total arsenic in a given sample and the amount of ("fixed") arsenic which remains in the ash (as an arseniate) when the finely powdered fuel is completely burned in an open platinum basin at a red heat. The results are valuable as being comparable *inter se*, but how far they can be taken as a satisfactory index of the amount of volatilisation which may take place under other conditions of combustion is, of course, a different matter. On the kiln fire, for example, the temperature to which the anthracite is exposed varies greatly—often it reaches a white heat. The fuel is burnt in bulk, and the anthracite is in lumps, often of considerable size. These lumps may be suddenly thrust into a hot fire where they slowly burn away from the outside. Thus part of the anthracite which is being heated or burnt in the kiln (for example, the interior of the lumps or the centre of the fire) will be exposed not to an oxidising, but in the first instance to a reducing atmosphere. Moreover, the period of combustion is much more prolonged in the kiln than in the laboratory, and the character of the combustion as regards supply of oxygen and temperature in the case of the kiln must vary greatly with the structure of the furnace and with the method of firing adopted. The influence of these and other factors in determining the proportion of arsenic which will become "fixed" in process of combustion and the amount which will be volatilised has seemingly yet to be ascertained. The only way to arrive at this would be to carry on a large series of duplicate combustions in a kiln and in the laboratory over a considerable period of time. (*cf.* the two Newark Experiments, Part VI., p. 322.)

Bearing of Results on the Selection of Malting Anthracite by Colliery Owners and by Maltsters.

The results above summarised show the extreme importance of careful exclusion, in the mine or on the surface, of all impurities which may be present in the veins worked for malting, and the need for constant supervision and watchfulness on the part of the colliery owner to ensure that his men carry this out properly and thoroughly, so that only "clean" anthracite is supplied to maltsters. It is essential to remove not only nodules of pyrites, lumps in which pyrites and coal are mingled, and bands of slate or shale attached to, or passing through, lumps of coal, but also any obvious granular "black" pyrites. In a seam where such granular black pyrites is present as a definite layer traversing the vein at a particular level, it can be more readily eliminated than where the pyritous portions are distributed irregularly throughout the vein. In the former case a system can be adopted as at Colliery H (see Mr. Price's Report), by which all pieces of anthracite in which the band is represented are rejected.

It is equally essential that maltsters should systematically keep a strict watch on the anthracite supplied to them with the view of detecting and discarding impurities of the kinds above mentioned.

It is important that "clean" anthracite, as supplied to maltsters, should from time to time be sampled for the colliery owner, and that the quantity of arsenic contained in it should be estimated and compared with all available data. For this purpose a thorough and accurate method of obtaining a fair sample is essential. This point cannot be too strongly emphasized. The analyses desired are for the information and guidance of the colliery, and not for the purpose of obtaining a favourable report on specially selected samples, for exhibition to maltsters.

Where more than one seam of anthracite is worked at a colliery, advantage may be gained by analysis of the seams separately, together with associated impurities. For example, at Colliery B. four seams are worked for malting coal, the "Big," "Green," "Gras Uchaf," and "Pump Quart" veins respectively. The samples from the last two, which are "solid" and have practically no impurities to be removed, and also the sample from the Big Vein, in which the impurities consist of large and easily-removed lumps of yellow pyrites, contained in each instance less arsenic than samples of "clean" anthracite taken from the "Green" Vein. This Green Vein also was found to have a band of impure top coal which showed 280 parts of arsenic per million. So far as arsenic is concerned, therefore, it would seem better not to work such a vein as the last named for the supply of malting fuel.

A similar contrast is afforded between the "Big" and "Brass" Veins in Colliery K.

When colliery owners run short of malting anthracite, they occasionally fulfil their orders by arrangements with owners of other collieries, and this of course is the regular practice of agents and middlemen in similar circumstances. Where this is done it would seem important that the person or firm who has undertaken to supply the maltster should inform him that the source of supply has been changed, and should ascertain that the new supply is satisfactory as regards removal of impurities.

The exceptional result obtained in the case of anthracite from Colliery Q shows that it is desirable that the maltster, besides taking steps to obtain a supply of anthracite that is "clean" and apparently free from visible impurities, should also take the precaution of occasionally submitting samples (thoroughly and fairly taken) to the analyst. This seems especially important when the supply is obtained from a new colliery, or when the maltster receives anthracite of a different character from that to which he has been accustomed.

G. S. B.

August, 1903.

APPENDIX No. 30.

TABLE I.

SAMPLES of Malting Fuel, ready for consignment to Maltster, as indicated by management of the Colliery.

COLLIERY.	Colliery Names of Seam or Seams of Anthracite worked at the Colliery.	Seam or Seams of Anthracite from which Maltsters are supplied.	Samples of Malting Fuel ready for consignment to Maltster, as indicated by management of Colliery.			
			Notes on Sample (collected between December 1901 and August 1902, unless otherwise stated).	Arsenic in parts per million.		
				Total.	"Fixed."	"Volatile."
COLLIERY A	Big Vein Green Vein. Gras Uchaf. Lower Pump Quart.	LOWER PUMP QUART	From railway waggons at colliery.	6·00	4·75	1·25
COLLIERY B	Big Vein Green Vein Stanllyd Gras Uchaf	BIG VEIN GREEN VEIN. STANLLYD. GRAS UCHAF.	From railway waggons at railway station near colliery.	4·67	3·14	1·53
COLLIERY C	Lower Pump Quart. Trequart.	LOWER PUMP QUART	From railway waggons at colliery.	3·12	1·60	1·52
COLLIERY D	Stanllyd Upper Pump Quart.	STANLLYD	From railway waggons at colliery.	8·00	4·00	4·00
COLLIERY E	Deep Stanllyd Gras Isaf.	DEEP STANLLYD	From railway waggons at colliery.	7·67	5·43	2·24
COLLIERY F	Big Vein Peacock. Tregloin.	BIG VEIN	From railway waggons at colliery.	3·04	1·58	1·46
COLLIERY G	Big Vein Peacock.	BIG VEIN	From railway waggons at colliery.	2·43	1·86	0·57
COLLIERY H	(Big Vein) Brass Vein.	BRASS VEIN	From screen, as no waggons available. Portions showing black band excluded.	5·43	4·86	0·57
COLLIERY J	Upper Four Foot Big Vein. Brass Vein.	BIG VEIN	At colliery :— (*a*) Provisional sample, 1902.	8·89	4·57	4·32
			(*b*) From several railway waggons, 1903.	8·00	6·86	1·14
COLLIERY K	Nine Feet Vein	NINE FEET VEIN	(*a*) From railway waggons at colliery, 1902.	4·80	2·70	2·10
	Brass Vein	BRASS VEIN	(*b*) From railway waggons at colliery, 1903.	3·10	2·64	0·46

Appendix 30.

APPENDIX, No. 30—*continued.*

TABLE II.—Samples from SEAMS of ANTHRACITE USED FOR MALTING at the several

COLLIERY.	Colliery Name of Seam or Seams worked for Malting Coal.	Sample taken underground representing the whole thickness of seam, exclusive of impurities stated to be systematically removed from the coal at the colliery.			
		Notes as to Sample.	Arsenic in parts per million.		
			Total.	"Fixed."	"Volatile."
COLLIERY A - -	LOWER PUMP QUART	—	3·67	2·57	1·10
COLLIERY B - -	BIG VEIN - - -	—	6·60	4·86	1·74
	GREEN VEIN - -	Sample (a), 1902 - - -	18·30	7·67	10·63
		Samples (b) and (c), 1903, taken in view of result (a):—			
		(b) Whole thickness of vein sampled at three different places in "No. 7 level." Aggregate sample representing the three samples thus obtained.	16·00	13·30	2·70
		(c) Similar to (b), but taken at three different places in another part of the mine, "No. 6 level."	6·35	5·71	0·64
	STANLLYD - - -	—	5·60	2·70	2·90
	GRAS UCHAF - -	—	3·20	2·71	0·49
COLLIERY C - -	LOWER PUMP QUART	—	2·83	2·25	0·58
COLLIERY D - -	STANLLYD - - -	—	3·86	2·20	1·66
COLLIERY E - -	DEEP STANLLYD - -	—	8·00	5·00	3·00
COLLIERY F - -	BIG VEIN - - -	—	4·00	3·04	0·96

APPENDIX No. 30—*continued.*

COLLIERIES VISITED, together with Samples of *Impurities* met with in those seams.

Impurities (other than fragments of roof or floor) liable to be met with in seam, and stated to be systematically removed from the coal at the colliery.

Nature of Impurity and Notes as to Sample.	Arsenic in parts per million.		
	Total.	"Fixed."	"Volatile."
No visible pyrites.			
Inferior coal at base of vein	8·67	6·29	2·38
Lumps of pyrites, chiefly yellow, 12 to 15 inches above bottom of vein.	180·00	70·00	110·00
No visible pyrites.			
Two-inch band of impure top coal, largely shale: thin band of yellow pyrites visible in a few portions.	280·00	68·57	211·43
Seam solid: no visible impurity.			
Seam solid: no visible impurity.			
No visible pyrites.			
Thin band of impure coal at base of vein	9·50	6·90	2·60
Impure coal at the top of the vein, about 10 inches thick	9·25	6·57	2·68
Pyrites in balls, about 2 feet from the bottom of the vein, sometimes irregularly distributed through the vein.	93·30	25·60	67·70
Practically no visible impurity.			
Black granular nodules occasionally met with	10·00	8·80	1·20
Strong impure coal at the top of the vein, 6 to 7 inches thick.	19·00	10·50	8·50
Black kidney-shaped lumps, occurring intermittently and infrequently in the upper and lower parts of the vein: lumps sometimes thinning out into small bands. (Sample consists partly of lumps and partly of bands: contains no visible yellow pyrites.)	12·00	3·60	8·40

Appendix No. 30.

APPENDIX, No. 30—*continued.*

TABLE II.—Samples from Seams of Anthracite used for Malting at the several

COLLIERY.	Colliery Name of Seam or Seams worked for Malting Coal.	Sample taken underground representing the whole thickness of seam, exclusive of impurities stated to be systematically removed from the coal at the colliery.			
		Notes as to Sample.	Arsenic in parts per million.		
			Total.	"Fixed."	"Volatile."
COLLIERY G - -	BIG VEIN - - -	Sample (a), taken 1,400 yards south-east of "New Pit."	2·00	0·86	1·14
		Sample (b), taken 1,100 yards west of "New Pit."	5·60	2·50	3·10
COLLIERY H - -	BRASS VEIN -	Sample (a). Inclusive of a thin band of bright granular coal, traversed by threads of yellow pyrites, situated about 9 inches below the top of the vein, and 1 to 3 inches thick. This band until 1902 was ordinarily included in malting coal.	8·00	7·55	0·45
		Sample (b). From another part of mine, also inclusive of above band.	8·00	7·25	0·75
		Sample (c). From another part of mine, where above band had disappeared, but impure coal was to be seen in middle and at base of vein.	8·00	6·67	1·33
COLLIERY J - -	BIG VEIN - - -	Sample is exclusive of dull black layer referred to in next column.	4·33	2·71	1·62
COLLIERY K - -	BIG OR NINE FOOT VEIN.	Sample (a), 1902 - - -	6·46	4·86	1·60
		Sample (b), 1903 - - -	8·00	7·00	1·00
	BRASS VEIN - -	Sample (a), 1902, taken where black layer referred to in next column was absent.	15·00	10·95	4·05
		Sample (b), 1902, taken where black layer was present, exclusive of layer.	5·67	2·14	3·53
		Sample (c), 1903, taken where black layer was absent.	6·67	6·00	0·67

APPENDIX, No. 30—*continued.*

Collieries visited, together with Samples of *Impurities* met with in those seams—*continued.*

Impurities (other than fragments of roof or floor) liable to be met with in seam, and stated to be systematically removed from the coal at the colliery.

Nature of Impurity and Notes as to Sample.	Arsenic in parts per million.		
	Total.	"Fixed."	"Volatile."
Impure granular coal clinging to roof of the vein, 1½ to 4 inches thick. (Sample from same spot as (a).)	23·00	11·50	11·50
Impure coal at bottom of vein in eastern portion of mine, about 3 inches thick. (Sample from same spot as (a).)	19·50	11·00	8·50
Black lumps of "pyrites" of irregular size and shape, sometimes on one plane, sometimes irregularly distributed. Lumps occasionally small and thinning out into the seam. (Sample from same spot as (b), consists of large, heavy black nodules showing a few minute specks of yellow pyrites).	2·50	2·17	0·33
Band of bright granular coal, traversed by threads of pyrites, situated about 9 inches below the top of the vein and 1 to 3 inches thick. Separate sample from those included in (a) and (b). Sample contained a little yellow pyrites.	15·33	8·67	6·66
Half-inch band of impure coal (largely shale) from middle of vein at same spot as (c).	6·40	4·29	2·11
Impure coal from base of vein at same spot as (c): contains bands of shale and carbonate of lime: no yellow pyrites.	83·33	36·67	46·66
Impure coal at top of vein - - - - - - - - -	4·00	1·52	2·48
Hard black layer, up to 3 inches thick, lying 9 inches and upwards from the bottom of the vein. This layer clings closely to the coal.	18·40	5·20	13·20
Irregular black band, very hard, about 2 feet above the bottom of the vein.	3·80	3·20	0·60
Black granular layer, from the same spot as sample (b) -	280·00	84·00	196·00

ppendix 30. APPENDIX, No. 30—*continued.*

TABLE III.

A.—Shewing, in descending order of level, all the SEAMS met with in the several

WEST.					Seams used for
Colliery letter - -	A.	B.	C.	D.	E.
Seams of Anthracite worked.	Big Vein.	BIG VEIN.			
	Green Vein.	GREEN VEIN.			
		STANLLYD.		STANLLYD.	DEEP STANLLYD.
	Gras uchaf.	GRAS UCHAF.		Upper Pump Quart.	Gras isaf.
	LOWER PUMP QUART		LOWER PUMP QUART.		
			Trequart.		

B.—Shewing, by a corresponding arrangement, the amounts of TOTAL ARSENIC (parts per million) estimated in systematically removed

WEST.					Figures for seams not used
Colliery letter - -	A.	B.	C.	D.	E.
Malting Samples -	6·0	4·67	3·12	8·0	7·67
Samples from Anthracite seams.	*6·33*	6·6			
	(a) *7·0* (b) *11·0*	(a) 18·3 (b) 16·00 (c) 6·35			
		5·6		3·86	8·0
	5·0	3·2		*0·57?*	—
	3·67		2·83		
			—		

* Exclusive of pieces containing black band, which, however

APPENDIX, No. 30—*continued.* Appen

TABLE III.

ollieries and the *name under which each Seam appears at each Colliery.*

malting in Capitals. EAST.

F.	G.	H.	J.	K.
			Upper Four foot.	
BIG VEIN.	BIG VEIN.	Big Vein.	BIG VEIN.	NINE FEET VEIN.
Peacock.	Peacock.	BRASS VEIN.	Brass Vein.	BRASS VEIN.
Tregloin.				

Samples taken in the mine from certain seams noted in A. Samples are *exclusive* of impurities stated to be at the Colliery.

for malting in *Italic* type. EAST.

F.	G.	H.	J.	K.
3·04	2·43	5·43*	(a) 8·89 (b) 8·0	(a) 4·8 (b) 3·1
			—	
4·0	(a) 2·0 (b) 5·6	—	4·33	(a) 6·46 (b) 8·00
—	*3·4*	(a) 8·0 (b) 8·0 (c) 8·0	*8·4*	(a) 15·0 (b) 5·67 (c) 6·67
—				

are included in the samples taken in the mine.

Appendix 30 REPORTS ON MALTING ANTHRACITE:—PART II

PART II.—NOTES BY MR. H. HAMMOND SMITH ON INQUIRIES AS TO ANTHRACITE USED BY CERTAIN MALTSTERS

The object of these inquiries was to ascertain the practice of certain maltsters in the selection and purchase of malting anthracite, and the mines from which their anthracite is obtained.

The maltings of four large firms were visited. These are situated respectively at Smethwick (taken as representing Western Counties Maltings); Burton-on-Trent (Midland Counties and other Maltings); Newark-on-Trent (Eastern Counties Maltings); and Sawbridgeworth (Southern Counties Maltings).

Information was kindly given me by the representatives of the firms concerned, including their analysts. I also took the opportunity of speaking to the men who handled the anthracite, and had the charge of the malting fires both in closed and open furnaces.

Exclusive use of anthracite.

All the maltsters I saw agreed in stating that since the discovery that malt might be arsenical, they have used only anthracite for malting purposes.

Brewers now usually stipulate that the malt they buy should all have been kilned by means of anthracite, and not by the use of coke. Two of the maltsters whom I saw said that they had previously used nothing but anthracite, but at other two, coke, said to be oven coke, was formerly used—principally in conjunction with anthracite to "finish" the malt.

Selection of Anthracite by the Maltster.

At two of the maltings visited the anthracite is ordered direct from the colliery or collieries, at the other two it is obtained through agents. But in either case the coal comes direct from the colliery to the malting.

At each of the maltings visited I was told that the anthracite is hand-picked over at the colliery, and any lumps of pyrites, or pieces of coal showing pyrites, are rejected. This is believed to be invariably done at the colliery, but no special stipulation as to the picking over was made by the maltsters. To a certain degree there is additional hand-picking at the malting by the furnace-men, who usually throw on one side pieces that show what they term "glitter" (pyrites), or that look dull. The latter are rejected because of the smoke they produce. Surprisingly large lumps of pyrites and other impurities are sometimes found in the anthracite as delivered to the maltsters.

Anthracite is generally bought and stored in the summer time, but some is also bought in the winter. The custom seems to be that once a particular colliery has been found to give a satisfactory anthracite, orders are renewed year by year to that colliery, without obtaining fresh samples. The anthracite has in the past been selected by the maltster as that which, in actual practice, he finds to burn best, and to produce the best flavoured malt. Thus in one instance, some years ago trials were made of samples from various collieries. As a result of these trials, one colliery was selected, and has been exclusively used ever since.

In two cases the maltster obtained his anthracite from one or two or more collieries, and occasionally a mixture of fuels is used on the kiln. In other cases the maltster ordered all his anthracite from a single colliery.

Collieries from which the fuel is obtained.

In the list of mines given in the report of H.M. Inspectors of Mines, 1900, there are 28 anthracite collieries in Brecon, Glamorgan, and Carmarthen mentioned which employ over 100 men. Out of these 28 I found that the four large maltsters visited get their supply of anthracite from only eight collieries, in addition to one which I was unable to identify; some of the maltsters visited were supplied from the same colliery or collieries.

Designation of Anthracite.

The coal used is said to come from the "deep seams," and "deep-seam anthracite," whatever may be its significance, is always asked for when ordering.

All the maltsters visited promised to let the Commission have samples of their fuel if required.

Analysis and guarantees of Anthracite by Colliery Owners.

Up to the present time anthracite has not been bought or selected on chemical analysis at any of the maltings visited, although analyses of the fuel as regards carbon, ash, &c., are frequently made by colliery owners and sent to maltsters.

By one maltster I was shown several analyses of recent date (1901) which he had received from colliery owners advertising their coals as "free from arsenic." By another maltster I was shown an analysis received from the colliery in which the analyst, after giving the amount of carbon, ash, etc., in 100 parts, said he could not detect more than ·000000026 per cent. of arsenic!

I found the maltsters visited attach no importance to analyses sent them from the collieries, and for this reason they do not ask for guarantees from the colliery owners that their coal is arsenic-free, nor do they require an analysis to accompany each fresh consignment of coal.

Selection and Analysis of Anthracite by Maltsters.

The coal up to now has been selected entirely for its burning and flavouring properties, and not on account of its freedom from arsenic. I found that at two of the maltings visited the maltsters had not had their anthracite analysed on their own account; the other two had done so.

At one malting I was told their own chemist had been analysing anthracite for arsenic, and other fuels also, and has had his analysis supplemented by an independent chemist. I was shown the analysis of samples of six South Wales anthracites. Out of these five showed from 1/70th to 1/50th of a grain of arsenic per lb. (2 to 3 parts per million), and one was "nearly free." These anthracites were samples taken from coals as delivered in the ordinary course and had been selected by the Chemist of the Works. By the same maltster's chemist I was shown analyses which he had made of samples of gas cokes and oven cokes as follows:—

Gas Coke.

		Per Million.
1. Yorkshire sample	1/14th grain per lb.	*10·2*
2. Nottingham sample	1/18th „ „	*7·9*
3. Lincolnshire sample	1/30th „ „	*4·8*

Oven Cokes.

4 (*a*). Derbyshire sample	1/30th grain per lb.	*4·8*
4 (*b*). Derbyshire sample	1/7th „ „	*20·4*
5. Babbington (washed)	1/35th „ „	*4·1*
6. Durham (washed)	1/30th „ „	*4·8*
7. Derbyshire (washed)	1/14th „ „	*10·2*

At one malting I was shown an analysis of the coal used from one colliery, made by Mr. Moritz. A sample was taken of 20 lumps from the different heaps in the yard, and the analyst reported that "a minute trace" (of arsenic) "has been found in it, which is quite negligible."

H. HAMMOND SMITH.

August, 1901.

REPORTS ON MALTING ANTHRACITE:—PART III. Appendix

PART III.—NOTES BY MR. A. STRAHAN, F.R.S. (DISTRICT GEOLOGIST), OF H.M. GEOLOGICAL SURVEY, ON VISITS MADE BY HIM TO CERTAIN SOUTH WALES COLLIERIES SUPPLYING MALTING ANTHRACITE.

Arrangement of Notes.

1. On the seams of anthracite worked in South Wales for malting purposes.

2. On the occurrence of pyrites and other impurities in the seams.

3. On the method in use of freeing the fuel from the impurities.

1.—On the seams of Anthracite worked in South Wales for Malting purposes.

The working of anthracite in South Wales is limited to the north-western part of the main coalfield, and also to the Pembrokeshire coalfield, in which there are a few collieries. The region which contains nearly all the collieries where anthracite is worked lies part in Carmarthenshire, part in Glamorganshire, and part in Brecknockshire. It extends from Carmarthen Bay on the west to the head of the Neath Valley, some 25 miles to the east, with a breadth from north to south of between two and four miles. To the north it is limited by the outcrop of the Coal Measures; to the south, where the seams descend to a great depth, their limits have not been ascertained, but there is reason to believe that they gradually lose their anthracitic character.

The ten collieries visited are representative of different parts of this region. For the purposes of these notes they are designated by letters, A to K, and are arranged in order from west to east; Colliery A is that nearest the western limit, and Colliery K is that nearest to the eastern limit of the region referred to. At each of these ten collieries the supply of malting anthracite constitutes an important part of the business of the Colliery Company. There are, of course, other collieries in their neighbourhood from which coal is supplied for malting purposes.

At each of the collieries visited information was kindly supplied to me by representatives of the Colliery Company, in most instances by the Manager, in other cases by the Secretary or Agent.

Five seams are worked for malting, but the greater part of the coal is got from one seam—namely, that which is known in various collieries as the *Stanllyd*, the *Big*, or the *Nine feet Vein*. This seam is generally stated to be superior to the others in calorific power and purity. The seams all occur in the lower part of the productive measures of the South Wales Coalfield. They crop out and are worked near the surface and at great depths below it, the term "deep," which is applied to some of them in the trade, having therefore no significance. Their sequence and approximate correlation are illustrated in the following Tables IV. and V.:—

APPENDIX, No. 30—*continued.*

TABLE IV.—Showing, in descending order of level, all the SEAMS met with at the several

WEST. Those used for

Colliery A.	Colliery B.	Colliery C.	Colliery D.	Colliery E.
Big vein.	BIG VEIN.			
Green vein.	GREEN VEIN.			
	STANLLYD.		STANLLYD.	DEEP STANLLYD.
Gras uchaf.	GRAS UCHAF.		Upper Pump Quart.	Gras isaf.
LOWER PUMP QUART.		LOWER PUMP QUART.		
		Trequart.		

TABLE V.—Showing *distribution* of visible (yellow or black)

Colliery A.	Colliery B.	Colliery C.	Colliery D.	Colliery E.
Pyrites occasionally met with.	Pyrites in lumps 12 ins. to 15 ins. above bottom of vein.			
Pyrites in lumps.	No pyrites, but 2 ins. of impure coal at top.			
	No pyrites.		Pyrites in balls, irregularly distributed about 2 ft. from bottom of vein.	No pyrites.
Pyrites present.	No pyrites.		Pyrites present in layer.	Pyrites in lumps, mostly black.
No pyrites.		No pyrites—a band of impure coal at bottom of seam, 3 ins.		
		Pyrites in threads, not in lumps.		

APPENDIX, No. 30—*continued.* Appendix 30.

Collieries visited, and the names under which they appear at the various Collieries.

MALTING in CAPITALS. EAST.

Colliery F.	Colliery G.	Colliery H.	Colliery J.	Colliery K.
			Upper Four foot.	
BIG VEIN.	BIG VEIN.	Big Vein.	BIG VEIN.	NINE FEET VEIN.
Peacock.	Peacock.	BRASS VEIN.	Brass Vein.	BRASS VEIN.
Tregloin.				

Pyrites in the above Seams in the several Collieries visited.

Colliery F.	Colliery G.	Colliery H	Colliery J.	Colliery K.
			Pyrites in layers at bottom.	
Black kidney-shaped lumps irregularly distributed.	Black lumps of irregular size and shape, irregularly distributed, sometimes on one plane.	(Not being worked at present).	Dull black layers 1½ to 2 ft. above bottom of bottom coal.	Irregular layer about 2 ft. from bottom of vein (granular coal and black pyrites mixed).
Pyrites present, more difficult of extraction than in Big Vein, small lumps adhering strongly to coal.	Both yellow and black, in a band about 6ins. from top of vein.	Thin band of bright coal traversed by threads of pyrites, about 9 ins. below top of vein.	Layer of brassy pyrites in top coal, sometimes quite absent.	Impersistent black layer nearer top than bottom of seam.
ditto.				

Appendix 30. DETAILS of the SEAMS showing PARTINGS other than those of PYRITES.

	Yards.	*Feet.*	*Inches.*
Colliery A:			
The coals are all solid. The Big Vein of this colliery lies about 57 yards higher in the series than the Big or Stanllyd Vein of the collieries further east.			
Colliery B:			
Big Vein. Solid coal of 6 ft. 6 in. to	0	7	0
Measures	12	0	0
Green Vein { Impure coal, 0 ft. 2 in. / Coal 2 ft. 6 in.	0	2	8
Measures	45	0	0
Stanllyd Vein. Solid coal 3 ft. to	0	3	3
Measures	12	0	0
Gras uchaf Vein	0	2	6
Colliery C:			
Lower Pump Quart Vein { Coal 2 ft. 9 in. / Impure coal 0 ft. 3 in.	0	3	0
Measures	9	0	0
Tre Quart Vein	0	2	0
The Lower Pump Quart lies about 150 or 200 yards below the Stanllyd Vein.			
Colliery D:			
Stanllyd Vein. Solid coal	0	5	6
Measures	12	0	0
Upper Pump Quart. Solid coal	0	3	6
Colliery E:			
Deep Stanllyd. Solid coal 4 ft. to	0	4	6
Measures	20	0	0
Gras isaf. Solid coal	0	2	6
Colliery F:			
Big Vein. Solid coal	0	4	6
Measures, about	20	0	0
Peacock Vein	0	3	6
Measures			
Tregloin Vein with partings, about	0	4	0
Colliery G:			
Big Vein { Coal 4 ft. 4 in. / Impure coal 2 in.	0	4	6
Measures, about	20	0	0
Peacock or Brass Vein	0	3	0
Colliery H:			
Big Vein			
Measures, about	20	0	0
Peacock or Brass Vein, 2 ft. 10 in. to	0	3	11
Colliery J:			
Upper Four Feet Vein			
Measures			
Big Vein { Top coal 2 ft. 0 in. / Parting of dirt 0 ft. 0½ in. / Middle coal 3 ft. 6 in. / Bottom coal 3 ft. 6 in.	0	9	0½
Measures, 20 yards to	23	0	0
Brass Vein { Top coal 0 ft. 3 in. / Parting 0 ft. 2 in. / Bottom coal 2 ft. 6 in.	0	2	11
Colliery K:			
Big or Nine Feet Vein. Solid coal 6 ft. 6 in. to	0	7	0
Measures	20	0	0
Brass Vein. Solid coal	0	3	0

2.—On the Occurrence of Pyrites and Other Impurities in the Seams.

The facts ascertained are summarised in tabular form in Table II.

No visible iron pyrites occurs in the following seams :—

Pump Quart Seam	Colliery A.
Green Vein, Stanllyd Vein, Gras uchaf Vein	Colliery B.
Pump Quart Vein	Colliery C.
Deep Stanllyd Seam	Colliery E.

In all the other seams named in the table, pyrites is visible in greater or less abundance. It occurs in lumps or thin impersistent bands, and takes one of two forms, namely, that of yellow pyrites, presenting the characteristic appearance of the mineral, or that of black material consisting largely of coal, but containing sulphide of iron in a form not distinguishable by eye. These will be referred to as yellow and black pyrites respectively.

Visible pyrites occurs in the following coals supplied for malting :—

In the Big Vein of B. Colliery (not the Stanllyd vein of other collieries). It takes the form of lumps, chiefly of yellow pyrites, lying about 12 or 15 inches above the bottom of the vein.

In the Stanllyd of D. It takes the form of balls, dark outside but usually yellow inside, lying about two feet above the bottom of the vein, but often irregularly distributed.

In the Big Vein of F. It takes the form of black kidney-shaped lumps which occur intermittently in the upper and lower parts of the seams. In the Big Vein of G it takes the form of black lumps of irregular size and shape. The lumps sometimes occur in one plane, but at others are irregularly distributed through the vein.

In the Brass Vein of H. It takes the form of a thin band of bright granular coal traversed by threads of yellow pyrites, and about one to three inches thick. This band usually lies about nine inches below the top of the vein, but disappears when the vein is thin. Small lumps of yellow pyrites also occur, but very rarely.

In the Big Vein of J it takes the form of dull black layers about 1½ to 2 ft. above the bottom of the bottom coal.

In the Big or Nine Feet Vein of K it takes the form of an irregular layer about two feet above the bottom of the vein; the layer consists partly of a bright granular coal, which is used as a fuel in the houses of the neighbourhood, and partly of black pyrites.

In the Brass Vein of K. It takes the form of an impersistent black layer lying nearer the top than the bottom of the vein. It generally shows thin seams or granules of yellow pyrites. The layer is sometimes absent for several hundred yards.

Impurities other than Pyrites.

Seams of anthracite are usually "solid," that is, consist of coal from top to bottom without any partings of clay or stone. All the coals referred to in the table are solid with the following exceptions :—

The Green Vein of B has at its top two inches of impure coal, which is rejected.

The Pump Quart Vein of C has at its bottom a band of impure coal about three or four inches thick, which is rejected.

The Big Vein of G has at its base one to three inches of impure coal, which is rejected. Appendix 30.

The Big Vein of J shows the following partings :—

	Ft.	in.
Top coal interbedded with layers of black stone and not worked with the rest of the vein*	2	0
Parting of dirt, about	0	0½
Middle coal	3	6
Bottom coal	3	6

In the case of all seams fragments of shale from the roof or floor are accidentally sent up in the trams. Fragments of the roof especially not infrequently adhere to the lumps of coal.

3.—On the Method in Use of Freeing the Coal from the Impurities.

The same method is in use at all the collieries, with slight differences in detail. The miner is supposed to pick out all visible pyrites, fragments of shale, etc.; but from the conditions under which he works is unable to do so completely.

The coal on reaching the top of the pit is tipped into an iron shoot, down which it passes with a rapidity which can generally be regulated. One or more men are stationed by the side of the shoot whose business it is to pick out pyrites or impure coal.

The coal then passes over two or more screens, in the last of which the bars are placed at distances apart varying from two to eight inches at different collieries. The small coal falls through, and large lumps only pass on to the truck for the maltster.

In this truck two or more men are stationed whose business it is to arrange the coal and throw out any impurities that have passed the men on the screens.

At all collieries it is stated that a special screen is kept for the malting coal, and that all screening is done in daylight.

As a rule no alteration has been made in the system in consequence of the demand for arsenic-free fuel, but in one or two cases the picking is done more carefully than it used to be.

Large lumps of coal in which no pyrites is visible are not broken, it being considered that pyrites, if it existed in them, would always show itself on their surface. Lumps in which pyrites shows itself are broken, and the coal generally put back upon the screen.

All the impurities picked out are thrown on the rubbish heap, except a certain form of bright coal associated with pyrites, which is used locally as a house coal.

At A the bars of the screen are 2½ inches apart. Coal in which pyrites is visible is thrown out and used for other purposes.

At B the bars of the screen are five inches apart. Three men are stationed by the screen for the purpose of picking. The coal then passes down a long shoot, when it is further picked over by a man and a boy. Lastly there are two men in the truck who also pick out any impurity. The long shoot was introduced in consequence of the demand for arsenic-free fuel.

At E the bars of the screen are five inches apart, or if requested, 3 inches apart. The impure coal, three or four inches thick at the bottom of the seam, is picked out on the screen and used for lime burning. It breaks readily and cleanly off the good coal.

* According to Mr. Price's notes on observations made in the mine, this top coal is also represented in the Big Vein of Collieries F and G, where also it is not worked for malting coal. Mr. Price also noted the occasional presence of a black band containing no visible pyrites in the Stanllyd Vein of Colliery E.

Appendix 30.

At D the bars are 3½ inches apart. The pyrites is thrown on the waste heap or burnt in the cottages of the neighbourhood. Previously to January, 1901, the Pump Quart was supplied to maltsters mixed with Stanllyd, but this caused complaints.

At E the bars are 4½ inches apart. Soft coal—even if in large lumps—is picked out, and nothing but hard coal in large lumps is sent to the maltster.

At F the bars are eight inches apart. Before the demand for arsenic-free fuel a conveyor arrangement had been introduced, by which the coal is conveyed from the screen to the truck. It is thus brought thoroughly into view, and can be freed from all visible impurities.

At G the bars are 3⅜ inches apart. The impurities are picked out by the miner, by the men on the screens, and by the men in the trucks. They consist of pyrites and of a band of impure coal, one to three inches thick at the bottom of the seam. It is believed that they are all removed.

At H the bars are 2½ or 3 inches apart. The coal is picked on the screens and in the trucks. Since the demand for arsenic-free fuel greater care has been exercised in picking out lumps containing the black band previously mentioned. But the band is closely blended with the coal, and does not break cleanly off it. If it is not more than about an inch thick it is not picked out.

At J the bars are two inches apart. The picking is done by two men on the screen and one in the truck. Lumps showing pyrites are wholly rejected. Fragments of shale from the roof of the seam are attached to many of the lumps of coal. They break cleanly off the coal and are thrown out.

At K the bars are three inches apart. Two men are employed on the screen and three in the truck. Large lumps showing pyrites are thrown out on to a special stage, broken up, and the coal thrown back on the screen. The two seams (Big and Brass Veins) are mixed.

Colliery Q. I visited one anthracite colliery which is outside the anthracite region above described. There were here two seams of solid coal, containing no visible pyrites or other impurity, respectively 1 foot 8 inches and 1 foot 4 inches in thickness, and separated by 70 yards of measures.

It may be noted that the measures of the coalfield in which Colliery Q is situated have been subject to great pressure and disturbance by earth movements in past geological ages. It is not improbable, therefore, that the seams have been crushed out and reconsolidated. Any partings or impurities which they originally contained may thus have become so incorporated with the coal as to be indistinguishable to the eye.

Analysis of anthracite made for the above collieries. The following table gives in each instance the analyses of the fuel as prepared for the maltster, and as furnished by the colliery proprietor. They have been made by different analysts at different dates and probably by different methods. It is not possible to say, therefore, how far they are comparable or reliable (pp. 306–7).

SAMPLES.

It is recommended that samples of the following should be examined for the occurrence of arsenic:—

A. Colliery:—

The Big Vein.
The Lower Pump Quart Vein.
The Green Vein.

B. Colliery:—

The Big Vein.
The Green Vein.
The Stanllyd Vein.
The Gras uchaf Vein.
Pyrites from the Big Vein.
A two-inch band of impure coal on top of the Green Vein.

C. Colliery:—

The Pump Quart Vein.
A three-inch band of impure coal at bottom of the vein.

D. Colliery:—

The Stanllyd Vein.
The Pump Quart Vein.
Pyrites in the Stanllyd Vein.

E. Colliery:—

The Deep Stanllyd Vein.
Pyrites in the Gras isaf Vein.

F. Colliery:—

The Big Vein.
Pyrites of the Big Vein.

G. Colliery:—

The Big Vein.
Pyrites in the Big Vein.
A three-inch band of impure coal at the bottom of the vein.

H. Colliery :—

The Brass Vein where no pyrites occurs.
The Brass Vein where pyrites does occur.
The band of supposed black pyrites which lies nine inches below the top of the vein.

J. Colliery :—

The Big Vein.
Pyrites in the Big Vein.
Top coal of the Big Vein.

K. Colliery :—

The Brass Vein where no pyrites is visible.
The Brass Vein where pyrites is visible.
Pyrites in the Brass Vein.
The Big Vein.
Pyrites in the Big Vein.
The roof of the Big Vein.

In every case it would be advisable to examine a fair sample of the fuel as prepared for the maltster.

AUBREY STRAHAN.

December, 1901.

Appendix 30.

APPENDIX, No. 30—*continued*.

TABLE VI.—ANALYSES furnished

	A.		B.			
	Lower Pump Quart Vein.	Big Vein.	Big Vein.	Green Vein.	Stanllyd Vein.	Gras Uchaf.
Carbon	93·90	94·28	89·80	92·33	92·88	92·88
Hydrogen	—	—	—	—	—	—
Oxygen	—	—	—	—	—	—
Nitrogen	—	—	—	—	—	—
Volatile matter	4·23	4·06	6·80	5·50	6·25	5·24
Sulphur	·65	·82	·90	·78	·86	·90
Ash	1·22	·84	3·40	1·30	·87	1·88
	100·00	100·00	100·90	100·00	100·86	100·90
Special Examination for Arsenic.	Entirely free.	Entirely free.	Minute trace.	Perfectly free.	Minute trace.	Quite free.

APPENDIX, No. 30—*continued.*

Appendix 30.

by COLLIERY PROPRIETORS.

C. Lower Pump Quart Vein.	D. Stanllyd Vein.	E.	F. Big Vein.	G.	H.	J.	K.	Q.
92·73	92·09	92·18	93·578	91·69	88·20	91·46	93·09	94·18
3·37	—	3·53	1·623	3·51	—	—	—	2·99
2·69	—	2·79	4·159	2·48	—	—	—	·50 ·76
—	7·04	—	—	—	9·60	6·60	5·37	—
0·45	0·93	0·45	0·118	0·70	·70	·74	—	·59
0·76	0·87	1·03	0·416 (moisture) 0·106	1·62	2·15	1·20	1·54	·98
100·00	100·93	100·00	100·00	100·0	100·65	100·00	100·00	100·00
$\frac{1}{10}$th grain per lb.	No trace.	Free.	—	Free.	Quite free.	—	Absolutely free from arsenic.	Entirely free.

Appendix 30. REPORTS ON MALTING ANTHRACITE.—PART IV.

PART IV.—REPORT ON COLLECTION OF SAMPLES FROM ANTHRACITE COLLIERIES IN SOUTH WALES, BY MR. S. WARREN PRICE, ASSOC. R.S.M., F.G.S., M.INST.MIN.ENG., LECTURER ON MINING IN THE UNIVERSITY COLLEGE, CARDIFF.

The samples were collected from the several collieries noted by Mr. Strahan at various dates between December 5th, 1901, and August 21st, 1902.

In collecting the samples I followed the general lines which had been agreed upon before I began my visits to the collieries.

SAMPLES TAKEN UNDERGROUND.

The samples of seams were taken in the mine by cutting out pieces with a sharply-pointed pick; the pieces being taken closely together throughout the vertical section of the seam, and being as nearly as possible of equal size; or (where it was possible to remove such pieces) they consisted of thin flakes extending downward over a considerable vertical extent, but of small sectional area, in the plane of the seam.

The object in view in all such cases was to secure a fair representation in the sample of each portion of the seam, such as would be realised by cutting grooves of uniform cross section throughout the whole depth of the coal from roof to floor. In the case of anthracite coal, cutting such grooves is particularly troublesome, and in practice the same result was attained by the separation of pieces in the way described at points so chosen that the whole of the vertical section of the seam was properly represented in the sample. The samples taken in the mine were in all cases obtained from freshly worked faces of coal, or from faces being worked.

In all cases where the seam contained bands of dirt, stone, pyrites, or inferior coal, and where such impurities were removed by the miners or at the surface, these impurities were carefully excluded from the average sample of the seam; and when portions of any of these impurities were taken for special samples, great care was observed in packing to prevent any portion of the special sample from mingling with the sample of the seam.†

It has in every case been stated by the colliery officials that visible pyrites, shale and other impurities are picked out either by the miner underground, or by the men employed at the surface for that purpose, where coal is being prepared for malting.

The samples of coal taken *in the mine* do not, therefore, include any obvious lumps or bands of pyrites or any other impurity that was capable of being removed in either of the above ways, with the exception of two special samples from Colliery H noted below.

Where thin films or small particles of pyrites or of a white mineral (? calcite) are found in joint planes, etc., in the coal, they are, of course, not rejected.

In some of the seams, as noted by Mr. Strahan, practically speaking no pyrites is visible. In others pyrites sometimes occurs in thin layers, black in colour and inconspicuous, and blending with the coal to which it firmly adheres. Sometimes these bands are the lateral extensions of small or thin lenticular nodules of pyrites; sometimes they are isolated and of small extent.

Evidence of the presence of impersistent thin streaks of pyrites was observed in portions of the Stanllyd seam at Colliery G and at Colliery F; also in the "Big Vein" at Collieries A and B.

With regard to obvious pyrites, which can be separated in the mine or on the surface, it is important to note that the thoroughness with which such impurities can be removed depends upon the method adopted and also upon the degree of visibility and the firmness of adherence, or otherwise, of the impurity to the coal.

For example, at Colliery D, the pyrites in the Stanllyd seam occurs chiefly in large rounded lumps which easily separate from the coal and are picked out underground by the miners. In this case the miner can hardly fail to make the separation.

On the other hand, some of the seams, particularly in the collieries to the east of the anthracite coalfield, Colliery H (Brass Vein), Colliery K (Brass Vein and Big Vein), and Colliery J (Big Vein), show pyrites in the form of a more or less continuous layer, of varying thickness, often 2 to 3 in., which blends with the coal, and cannot be removed cleanly either in the mine or at the surface. In such cases exclusion of pyrites by the miner or picker needs much more care and attention. The way in which it is effected is by the picker who examines the coal on the surface removing all lumps in which the band of pyrites appears. If the lumps are large they are broken with a pick. The impure coal thus separated is used for boiler fires, or for local consumption as house coal.

In this connection I should note as regards the Brass Vein at Colliery H, that at the date of Mr. Strahan's visit, the custom was to choose malting coal from places where the pyritic layer is comparatively thin, and to allow pieces of coal in which the layer was not more than about an inch thick to be included in malting fuel. When I visited this colliery, however, I was informed that the method of picking the coal for malting had been altered within the last few months. At present the coal, after passing over a long inclined fixed screen, is received upon a plate from which it can be sent to either side into railway waggons for ordinary sales. When malting coal is being loaded the men have to drag or lift the lumps from the plate at the bottom of the inclined screen on to a narrow platform, and then pass the coal down a separate shoot into the railway waggons placed to receive it on a line of rails parallel to the former. It is claimed as an advantage that as the men must lift or move every lump of coal that goes into the malting coal waggon they have a good opportunity to satisfy themselves that there is no streak or band of pyrites in it, and are more likely to let such pieces pass into the waggons for ordinary classes of coal than to trouble to lift them into the malting coal waggon. The objection to this proceeding, of course, is the labour and time involved.

A somewhat similar system was followed at Collieries J and K. In each case the streak of pyrites is continuous, distinct, and in one plane, so that, although the band of pyrites cannot be removed by itself from the lumps without taking coal with it or leaving pyrites behind, yet it is not difficult to secure the removal of lumps of coal containing the band.

As regards collection of samples in these cases. At the Brass Vein of Colliery H, in view of the former custom noted by Mr. Strahan, I took two samples in the seams at points where the band of pyritic coal was fairly thick (1 to 2 in.) and included the bands in the sample—notes being given to the analyst of the proportions in which the coal and the band should be combined in order to make a representative sample of the seam. I also took a sample representing the whole thickness of the seam at a point where the band of pyrites was absent.

† When more than one sample was enclosed in a box the smaller ones were separately wrapped closely in several thicknesses of strong paper and tied securely. Large samples were usually enclosed in separate boxes, but when this could not be done, the box was divided into two parts by a closely fitted division or partition, fixed in place by the carpenter at the mine.

In the case of the Big Vein at Collieries J and K and of the Brass Vein at the latter, I excluded the layer of pyritic coal from the samples, but, as in the case of pyrites elsewhere, I took a special sample of the layer.

In all cases the whole operation of collecting the sample, labelling it and packing it up was carried out (except the final packing for those packed at Cardiff) by myself in the presence of the manager or some other official of the colliery, and the latter was in all cases invited to assure himself that the samples were correctly labelled and kept distinct.

Samples were collected in sample bags and labelled, and were transferred to the wooden boxes afterwards—usually at the colliery office. Owing to the fact that the sample required was of considerable weight, 20 lbs., it was seldom considered necessary to take a larger sample and reduce by "quartering." Ordinarily it was found to be possible to secure a completely representative sample without taking more than was required to be sent to the analyst In some cases however, a first large sample was halved by breaking each piece and rejecting half of it.

I have made a point in collecting the samples of ascertaining whether the colliery manager or his representative considered the seam in the place chosen for sampling to be of a fair average character. I wished them to feel that the samples were fairly taken.

In nearly all cases I have details of the positions in the mine workings where the samples were taken, and can thus, if desired, show the positions on a map or plan. I have prepared sections in certain cases where the seam was not "solid," but contained partings or definite layers of impurity.

SAMPLES OF MALTING COAL.

In sampling the method followed was to make a heap, derived from as large a bulk as possible of the coal which had already been prepared for sale to the maltster. The anthracite usually being in large lumps, some of these were either broken down or pieces were broken off from a number of the lumps.

The bulk sample was then carefully reduced to the size (about 20 lbs.) required by Dr. McGowan.

In writing to make appointments I always stated that samples would be required. In a few cases, noted below, however, there was some difficulty, as I was informed that there were no trucks of malting coal at hand.

The following is a list of the samples of malting coal collected with comments upon each :—

Colliery A.—Sample taken from two waggons in presence of the Agent.

Colliery B.—No malting coal was being loaded at the time of my visit, and the screens had been temporarily altered for supplying other classes of coal.

I obtained a good average sample from about five waggons in a long train of them which were standing on the sidings at Llanelly. A clerk accompanied me to point out the waggons which contained malting coal.

Colliery C.—An average sample was obtained from three waggons in presence of the Manager.

Colliery D.—An average sample of the malting coal was obtained from three railway waggons in presence of the Sales Agent.

Colliery E.—An average sample of the malting coal was obtained from four railway waggons in presence of the son of the Underground Manager.

Colliery F.—An average sample of malting coal was taken from two railway waggons, in presence of the Foreman of the Surface Works.

Colliery G.—An average sample of the malting coal was taken from two railway waggons in the presence of the General Manager. There were a number of waggons of other coal, but the Manager stated that not more than the two waggons contained malting coal.

Colliery H.—The colliery was not working on the day when I visited it owing to deficiency of railway waggons, and there were no railway waggons loaded with malting coal at the colliery. In order to obtain a sample representing the malting coal I got the Manager to explain the system in use for selecting coal for malting (*see above*) and the official who had accompanied me underground then placed a number (about 12) of large pieces of coal on the platform in the same way as would be done when selecting coal for malting, and I took a sample from them. The quantity of coal in the inclined screen and on the plate at the bottom from which the lumps were taken would amount to several tons. Appendix 30.

Colliery J.—In this case no malting coal whatever was being loaded on the day when I visited the colliery, and there were no waggons loaded either there or at any place near the colliery.

The sample which I obtained I cannot, therefore, regard as quite satisfactory, and it was merely taken provisionally. One railway waggon was said to contain coal from the Big Vein from which malting coal is obtained, but it was said that this coal had not been cleaned as carefully as when sold for malting. Two others (out of a number) were said to contain coal from both Big and Brass Veins—the latter not used for malting.

The sample was taken from these three waggons, pieces being chipped from Big Vein coal only. It was taken in presence of the Colliery Surveyor. A second sample of malting coal was taken from railway waggons in April, 1903, in the presence of the Manager, which should prove a reliable sample.

Colliery K.—A sample of malting coal was taken from two or three railway waggons loaded with malting coal that were standing at the colliery.

Colliery Q.—There were no railway waggons loaded here with malting coal, but a large stock pile almost 15 feet high was carefully sampled. In April, 1903, I obtained a second sample of anthracite from this colliery, again from a large stock pile, which was carefully sampled all over its surface.

I should add that in April, 1903, I also re-visited Collieries A, B, and K, to obtain certain supplementary samples desired. These were taken in the same way as before. In the Green Vein of Colliery B, each sample represented an aggregate of samples of the whole thickness of the seam (except its top coal, which is rejected), taken from different points. In the new samples of the Brass Vein at Collieries J and K, and of the Big Vein at the latter, the layer of pyritic coal which traverses the seam was, as before, not included in the sample.

REMARKS ON THE PICKING AND SCREENING OF ANTHRACITE.

Anthracite is prepared in carefully graded sizes for various uses other than malting. These remarks refer solely to the preparation of the large clean lumps of anthracite supplied to the maltster.

In the older method, the trams of coal from the mine are tipped on to an arrangement consisting of a long inclined shoot combined with inclined screens formed of fixed iron bars.

The bar screens permit the coal below a certain size to fall through, while the larger lumps slide downwards over the bars and finally drop into the railway waggons. There is a moveable door or gate at the bottom of the screen to regulate the descent of the coal. As the coal slides downwards, and while it remains for a short time stationary on the screens, it is examined by men standing at the sides of the shoot who pick out and throw aside any pieces of pyrites, shale, dirty coal, etc., that they see. Pieces adhering to lumps of coal are broken off with a light pick—in most cases this is easily done, but there are some cases where the impurity is too closely united to the coal for this to be done effectively, as I have pointed out above.

The chief disadvantage of the inclined shoot lies in the fact that the coal when tipped on to it from the tram rushes down quickly until it is checked by the moveable door or by the coal which may have been retained in the tower part. During its descent, it at first moves too rapidly to be examined properly, and finally, when checked and held in the bottom of the shoot by the moveable door, it is usually too closely packed together to allow of the whole of the lumps being examined.

In some cases the screen is placed at a more moderate inclination so that the coal has to be pushed slightly to

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make it slide downwards. This gives the pickers a slightly better opportunity to examine the coal. Where these inclined shoots are in use it is usual to have one or two pickers in the railway waggons also.

A much more effective arrangement is that in which the coal first passes over screens—either of the "fixed bar" or of the moving or "jigging" type—whereby the small coal is removed. The large coal from the screens then slides on to a travelling picking belt or table. This picking band or table consists of an endless chain running over rollers and covered with narrow steel plates, and presents a horizontal surface about 4½ feet wide by 30 to 60 feet in length (varying according to circumstances). It moves constantly in one direction, and the coal (which slides on to it in such a way as to be spread over the whole width and evenly distributed along its length) can be thoroughly examined by the pickers who stand at the sides. The pickers have thus a better opportunity to detect any impurities in the coal, and are better able to remove them than in the arrangement first described. These travelling picking belts are in use at a few anthracite collieries, and one was being installed at one of the collieries visited. They are in use at a very large number of steam coal collieries.

Supervision of the pickers and a good light to work in are, of course, essential to the satisfactory use of these methods.

In view of the increasing demand for good malting anthracite, colliery-owners will probably find advantage in considering how far their present methods of cleaning this class of coal can be improved. At the same time, the consumer should bear in mind that it is not possible on a commercial scale to turn out a product absolutely free from all impurities.

S. WARREN PRICE

June, 1903.

[REPORTS ON MALTING ANTHRACITE.—PART V. Appendix 30.

PART V.—REPORT ON THE EXAMINATION OF MALTING ANTHRACITES, AND OTHER SPECIMENS SUBMITTED IN COURSE OF THE COMMISSION'S INQUIRY AS TO ARSENIC IN MALTING FUELS, BY DR. G. MCGOWAN.

In submitting the accompanying tabular statement of results (Table VII., below) to the Commission, I may be allowed to call attention to a few points as follows :—

1. This work has been carried out in my laboratory by Mr. R. B. Floris, A.I.C. It has been arduous and prolonged, and I would here express my thanks to him for the great care which he has taken throughout. Any improvements in the methods followed, which have come in the course of working, have been mainly due to him.

2. The details of the analytical process followed in the case of fuels have already been sufficiently given in the joint paper by Mr. Floris and myself which has already been submitted to the Commission (Appendix 23). It is, therefore, unnecessary to say anything further on this subject, except that the method might probably be appreciably shortened (in the absence of any considerable quantity of copper) by re-igniting the precipitated sulphide of arsenic with lime, and "Marshing" the hydrochloric acid extract of the residue directly. This modification was first suggested by Mr. R. S. Finlow in connection with the examination of other substances for the Commission.

3. The necessity for very careful sampling from bulk, and of careful "sub-sampling" in the Laboratory (*cf.* Appendix 23), in the case of fuels, cannot be too strongly insisted upon.

4. All the samples of coal examined contained large quantities of iron relatively to the arsenic present, some of course much more than others; the "Big Vein" samples, for instance, contained a great deal. With regard to the anthracites proper, speaking generally, one might say that the softer the coal the more iron there was present.

5. In the estimations of arsenic, as far as possible, mirrors approximating to the standard (*i.e.* the precipitated standard) of 0·02 mgrm. As_4O_6 were read; but, of course, there were many exceptions to this.

6. In a few cases, where the results obtained in the first instance were for one or another reason unsatisfactory, several different mirrors were made from more than one precipitation (this is not shown in the tables).

7. Nos. 45 and 46 may be taken as an example of two impure coals presenting much the same appearance, but containing totally different quantities of arsenic.

8. It will be noted that in the samples which contained visible yellow pyrites, the volatile arsenic constituted a large percentage of the total arsenic present.

9. In some of the impurities, *e.g.* No. 37, No. 60 and No. 62, the results show the "volatile" arsenic as coming out very low, but it should be borne in mind that there was very little combustible matter altogether in these samples.

GEORGE McGOWAN.

Ealing, London, W.,
July 7th, 1903.]

Appendix 30.

Appendix, No. 30—*continued.*

Table VII.—Results of Examination of Malting Anthracites and other Specimens

Consecutive Number.	Sample Number.	Anthracite Colliery.	Nature of Sample.	Notes as to Collection and Appearance of Sample.
1	36	COLLIERY A	Malting Coal	From railway waggons. Very hard sample of anthracite.
2	37	ditto	Lower Pumpquart Vein, taken underground.	Very hard sample of anthracite
3	39	ditto	Green Vein, taken underground	——
4	64	ditto	Green Vein, taken at a point in the workings about ½ mile from the mouth of the incline.	Second sample, April 1903, for comparison with Green Vein Nos. 10, 11 and 12.
5	40	ditto	Big Vein, taken underground	——
6	52	ditto	Gras Uchaf Vein, taken underground.	——
7	38	ditto	Inferior coal at base of lower Pumpquart Vein.	——
8	28	COLLIERY B	Malting Coal	From railway waggons at station near colliery.
9	24	ditto	Big Vein, taken underground	——
10	25	ditto	Green Vein, taken underground	——
11	63	ditto	Average of the Green Vein underground at three separate points in the workings above No. 7 level.	Second sample, April 1903
12	62	ditto	Average of the Green Vein underground at three separate points in the workings above No. 6 level.	Second sample, April 1903
13	26	ditto	Gras Uchaf Vein, taken underground.	——
14	27	ditto	Stanllyd Vein, taken underground.	——
15	53	ditto	2-inch band at the top of the Green Vein.	Consisted largely of shale. A thin band of yellow pyrites to be detected in some fragments.
16	54	ditto	Pyrites from the Big Vein	Contained large veins of yellow pyrites. Very heavy sample.

APPENDIX, No. 30—*continued.* Appendix 30.

submitted in course of the COMMISSION'S INQUIRY as to ARSENIC in MALTING FUELS.

Arsenic expressed as Arsenious Oxide in parts per million.			Volatile Arsenic per cent. of Total Arsenic.	Notes as to Analysis, &c.
Total.	Fixed.	Volatile.		
6·00	4·75	1·25	20·8	
3·67	2·57	1·10	30·0	
7·00	5·72	1·28	18·3	
11·00	6·86	4·14	37·64	
6·33	2·33	4·00	63·2	
5·00	4·29	0·71	14·2	
8·67	6·29	2·38	27·5	After ignition, both with and without lime, a considerable bulk of whitish ash was left, not appreciably soluble in hydrochloric acid.
4·67	3·14	1·53	32·7	
6·60	4·86	1·74	26·4	
18·30	7·67	10·63	58·1	
16·00	13·30	2·70	16·9	
6·35	5·71	0·64	10·1	
3·20	2·71	0·49	15·3	
5·80	2·70	2·90	51·8	
280·00	68·57	211·43	75·5	
180·00	70·00	110·00	61·1	On dissolving the lime residue (in the determination of the total arsenic) in hydrochloric acid, an oily layer separated out.

Appendix 30.

APPENDIX, No. 30—*continued.*

TABLE VII.—Results of Examination of Malting Anthracites and other Specimens

Consecutive Number.	Sample Number.	Anthracite Colliery.	Nature of Sample.	Notes as to Collection and Appearance of Sample.
17	8	COLLIERY C	MALTING COAL	From railway waggons
18	9	ditto	Lower Pumpquart Vein, taken in the mine.	——
19	10	ditto	Thin band of dirty coal, from bottom of Pumpquart Vein.	——
20	4	COLLIERY D	MALTING COAL	From railway waggons
21	49	ditto	Stanllyd Vein, taken underground.	——
22	7	ditto	Pumpquart Vein, taken underground.	——
23	5	ditto	Pyrites from the Stanllyd Vein	This sample was a heavy pyrites — largely copper pyrites — apparently replacing small fossils.
24	6	ditto	Pyrites from the Pumpquart Vein.	Large masses of yellow pyrites. The black portions of the sample showed a conchoidal fracture.
25	50	ditto	"Board" or impure top coal from Stanllyd.	——
26	21	COLLIERY E	MALTING COAL	From railway waggons
27	22	ditto	Stanllyd Vein taken underground ¾ mile from shaft of colliery.	——
28	51	ditto	Black nodules from Stanllyd Vein.	Black material with no visible yellow pyrites. Fairly soft.
29	20	COLLIERY F	MALTING COAL	From railway waggons
30	17	ditto	Big Vein taken in the mine ¾ mile from the mouth of the level.	——
31	18	ditto	Impure top coal 6 or 7 inches thick.	——
32	19	ditto	"Pyrites" of Big Vein taken in the mine.	Small black masses, some being portions of bands—no visible yellow pyrites.

APPENDIX, No. 30—*continued.* Appendix 30

submitted in course of the Commission's Inquiry as to Arsenic in Malting Fuels—*continued.*

Arsenic expressed as Arsenious Oxide in parts per million.			Volatile Arsenic per cent. of Total Arsenic.	Notes as to Analysis, &c.
Total.	Fixed.	Volatile.		
3·12	1·60	1·52	48·7	
2·83	2·25	0·58	20·4	
9·50	6·90	2·60	27·4	A considerable bulk of ash, &c.
8·00	4·00	4·00	50·0	
3·86	2·20	1·66	43·0	
0·57(?)	0·63(?)	0·00(?)	0·0(?)	
93·30	25·60	67·70	72·6	
1300·00	333·33	966·67	74·4	
9·25	6·57	2·68	29·0	A considerable bulk of ash, &c.
7·67	5·43	2·24	29·2	
8·00	5·00	3·00	37·5	
10·00	8·80	1·20	12·0	
3·04	1·58	1·46	48·0	
4·00	3·04	0·96	24·0	
19·00	10·50	8·50	44·7	A considerable bulk of ash, &c.
12·00	3·60	8·40	70·0	

Appendix 30.

APPENDIX, No. 30—*continued.*

TABLE VII.—Results of Examination of Malting Anthracites and other Specimens

Consecutive Number.	Sample Number.	Anthracite Colliery.	Nature of Sample.	Notes as to Collection and Appearance of Sample.
33	11	COLLIERY G	MALTING COAL	From railway waggons
34	12	ditto	Big Vein, taken in the mine 1,400 yards S.E. of New Pit.	—
35	14	ditto	Big Vein, taken in the mine 1,100 yards on the west side of New Pit.	—
36	29	ditto	Peacock Vein, taken underground.	—
37	15	ditto	"Pyrites" of Big Vein, part of a large nodule from same spot as No. 35.	Hard, heavy black mass, showing a few minute specks only of yellow pyrites.
38	13	ditto	Impure bottom coal from Big Vein taken at the same spot as No. 34.	—
39	16	ditto	Impure granular top coal from Big Vein, 1½ to 4 inches thick, taken at the same spot as Nos. 34 and 37.	—
40	45	COLLIERY H	MALTING COAL	—
41	46	ditto	Brass Vein, together with black granular band traversing the vein at the same spot; the whole sample representing a section of the vein.	The black band in these samples, 41 and 42, consisted of granular anthracite with a considerable black band running through it. No visible yellow pyrites in the band.
42	47	ditto	Similar sample from Brass Vein from another spot, also including band.	
43	56	ditto	Another sample from Brass Vein, taken where black band was absent. Sample represents a section of the vein.	—
44	48	ditto	Granular band in Brass Vein traversed by threads of yellow pyrites, sampled separately.	The notes given under No. 47 apply here also, excepting that the anthracite and the black band were more sharply separated in this sample.
45	57	ditto	Impure coal from the middle of the Brass Vein.	Half-inch parting, consisting largely of shale.
46	58	ditto	Impure coal from the bed of the Brass Vein.	Contained bands of shale and carbonate of lime. No visible yellow pyrites.

Appendix 30.

APPENDIX, No. 30—*continued.*

submitted in course of the Commission's Inquiry as to Arsenic in Malting Fuels—*continued.*

Arsenic expressed as Arsenious Oxide in parts per million.			Volatile Arsenic per cent. of Total Arsenic.	Notes as to Analysis, &c.
Total.	Fixed.	Volatile.		
2·43	1·86	0·57	23·5	
2·00	0·86	1·14	57·0	
5·60	2·50	3·10	55·4	
3·40	2·57	0·83	24·4	
2·50	2·17	0·33	13·2	
19·50	11·00	8·50	43·6	A very considerable bulk of whitish ash was left, not appreciably soluble in hydrochloric acid.
23·00	11·50	11·50	50·0	A considerable bulk of ash, &c.
5·43	4·86	0·57	10·4	
8·00	7·55	0·45	5·6	
8·00	7·25	0·75	9·4	
8·00	6·67	1·33	16·6	
15·33	8·67	6·66	43·4	
6·40	4·29	2·11	32·9	
83·33	36·67	46·66	56·0	

Appendix 30.

APPENDIX, No. 30—*continued.*

TABLE VII.—Results of Examination of Malting Anthracites and other Specimens

Consecutive Number.	Sample Number.	Anthracite Colliery.	Nature of Sample.	Notes as to Collection and Appearance of Sample.
47	44	COLLIERY J - -	MALTING COAL - - - -	From single waggon, 1902 -
48	65	- ditto - - - -	MALTING COAL - - - -	From several waggons, April, 1903.
49	41	- ditto - - - -	Big Vein, taken underground ½ mile from the shaft.	——
50	66	- ditto - - - -	Brass Vein, taken underground (where no pyrites visible).	Sample taken April 1903 to compare with Nos. 43 and 58.
51	42	- ditto - - - -	Black layer from Big Vein -	Hard black material with a few minute specks of visible yellow pyrites.
52	43	- ditto - - - -	Top coal from Big Vein - -	——
53	30	COLLIERY K - -	MALTING COAL - - - -	From railway waggons, 1902 -
54	69	- ditto - - - -	MALTING COAL - - - -	From railway waggons, April 1903.
55	31	- ditto - - - -	Big or 9 ft. Vein, taken underground.	——
56	68	- ditto - - - -	Big Vein taken underground -	Second sample, April 1903 -
57	33	- ditto - - - -	Brass Vein underground where no pyritous layer present.	——
58	56	- ditto - - - -	Brass Vein underground where pyritous layer was present, exclusive of layer.	——
59	67	- ditto - - - -	Brass Vein taken underground where no pyritous layer present.	Second sample, April 1903 -
60	32	- ditto - - - -	Roof of Big Vein - - -	——
61	34	- ditto - - - -	Black pyritous layer from Brass Vein taken from the same spot as 58	Granular black band closely adherent to clean anthracite. This sample contained more coal, relatively to the band, than No. 62.
62	35	- ditto - - - -	Black band from Big Vein -	Black band mixed with anthracite; no visible yellow pyrites: very hard.

APPENDIX, No. 30—*continued.*

submitted in course of the Commission's Inquiry as to Arsenic in Malting Fuels—*continued.*

Arsenic expressed as Arsenious Oxide in parts per million.			Volatile Arsenic per cent. of Total Arsenic.	Notes as to Analysis, &c.
Total.	Fixed.	Volatile.		
8·89	4·57	4·32	48·6	
8·00	6·86	1·14	14·2	
4·33	2·71	1·62	37·4	
8·40	6·57	1·83	21·8	
18·40	5·20	13·20	71·7	
4·00	1·52	2·48	62·0	A considerable bulk of ash, &c.
4·80	2·70	2·10	43·7	
3·10	2·64	0·46	14·8	
6·46	4·86	1·60	24·7	
8·00	7·00	1·00	12·5	
15·00	10·95	4·05	27·0	
5·67	2·14	3·53	62·2	
6·67	6·00	0·67	10·0	
3·25	2·00	1·25	38·5	This sample contained but little carbon, i.e., was mainly composed of incombustible matter.
280·00	84·00	196·00	70·0	
3·80	2·20	0·60	15·8	

Appendix 39.

APPENDIX, No. 30—*continued.*

TABLE VII.—Results of Examination of Malting Anthracites and other Specimens

Consecutive Number.	Sample Number.	Anthracite Colliery.	Nature of Sample.	Notes as to Collection and Appearance of Sample.
63	*1*	COLLIERY Q	MALTING COAL	From stock pile at colliery
64	*61*	ditto	MALTING COAL	Second sample, April 1903, from large stock heap at colliery.
65	*2*	ditto	Vein I, taken underground	——
66	*3*	ditto	Vein II, taken underground	——
	SAMPLES OF GAS COKE FROM YORKSHIRE GAS WORKS.			
67	—	Gas Works; Yorkshire Corporation, A.	Gas coke at Gas Works at date of visit, 1903.	Sampled from large bulk
68	—	Gas Works; Yorkshire Corporation, A.	Old sample of gas coke, 1901, kept at Gas Works.	——
69	—	Gas Works; Yorkshire Corporation, B.	Recent sample gas coke at Gas Works, 1903.	Sampled from large bulk
70	—	Gas Works; Yorkshire Corporation, C.	ditto ditto	ditto ditto
	SAMPLES OF OVEN COKE FROM MIDLAND IRON WORKS.			
71	—	N. Wales oven coke	——	Sampled from a single truck
72	—	Yorkshire oven coke	——	ditto ditto
73	—	S. Wales oven coke, A.	From washed coal	ditto ditto
74	—	S. Wales oven coke, B.	From washed coal burnt in a Coppée oven.	ditto ditto

APPENDIX, No. 30—*continued.* Appendix 30.

submitted in course of the Commission's Inquiry as to Arsenic in Malting Fuels—*continued.*

Arsenic expressed as Arsenious Oxide in parts per million.			Volatile Arsenic per cent. of Total Arsenic.	Notes as to Analysis, &c.
Total.	Fixed.	Volatile.		
90·00	73·00	17·00	18·9	
50·00	38·33	11·67	23·3	
2·57	1·40	1·17	45·5	
7·20	5·14	2·06	28·6	
125·00	116·70	8·30	6·4	
35·70	28·50	7·20	20·2	
200·00	133·30	66·70	33·3	
144·40	127·80	16·60	11·5	
8·50	8·50	0·00	0·0	
11·87	11·25	0·62	5·2	
30·00	27·50	2·50	8·3	
5·75	5·25	0·50	8·7	

Appendix 30A REPORTS ON MALTING ANTHRACITE.—PART VI.

PART VI.—ACCOUNT OF TWO EXPERIMENTS AT MALT KILNS AT NEWARK.

Soon after commencing his analyses of samples of anthracite, Dr. McGowan pointed out that the value of the work on which he was engaged would be enhanced by an experiment made at a malt kiln to determine under practical conditions the amounts of arsenic respectively in the anthracite consumed, in the residue after combustion, and in the malt produced. Mr. Earp's evidence to the Commission indicated that the question of arsenic in malt was being closely studied at the maltings of Messrs. Gilstrap, Earp and Co., and advantage was taken of an offer kindly made by Mr. Walter Hervey to conduct an experiment of the kind required at one of the malt kilns of this firm in Newark.

FIRST EXPERIMENT, 1902.

On March 21st, 1902, a 30-quarter kiln was selected and its furnace was thoroughly swept out. A weighed quantity of anthracite was set aside. The anthracite used was part of a sample truck sent from a South Wales colliery, which had been considered unsatisfactory and liable to cause arsenical contamination of the malt to a degree which was well marked by the Reinsch test, the test habitually used at these maltings.

The experiment was conducted under Mr. Hervey's supervision. The anthracite was sampled before the kiln was loaded, and weighed; the fire was started with wood.

On March 25th the malt was taken off the floor and screened by hand. The malt and culms were put up in bags and weighed; the weight of the unused anthracite was taken and deducted from the weight of that which had originally been set aside. The residue from combustion was separated into three portions—(1) ash and fine cinders which had passed through a half-inch riddle; (2) cinders which were rejected by the riddle; and (3) a few slag-like portions termed "dross."

The weights were as follows:—

Anthracite burnt—1 ton, 3 cwt., 14 lbs. = 2,590 lbs.

Cinder, 23 stone, 9 lbs. = 331 lbs.

Ash, 39 stone, 11 lbs. = 557 lbs.

Dross, 13½ lbs.

Malt, 32 qrs., 6 bushels = 11,004 lbs.

Culms, 363 lbs.

These weights were taken carefully under Mr. Hervey's supervision on March 25th, and samples of the anthracite, cinder, ash, dross, malt, and culms were sent to Dr. McGowan.

Owing to various circumstances, examination of these samples in Dr. McGowan's laboratory was necessarily delayed, and the whole results were not available for comparison until the end of the year. They are shown in the first part of Table VIII.

Two points should be noted with regard to this experiment. The question arose, in view of the analytical results obtained, whether the sample of anthracite had been representative. Mr. Hervey reported that it had been sampled by selecting a bulk of pieces which looked typical of the whole and (after breaking and mixing) taking a portion of this bulk sample for analysis. In his view, however, it was quite likely that by this method a considerable amount of pyrites which may have existed—secreted as it were—in the anthracite was not represented in the analysed sample. It will be seen that the proportion of arsenic determined in the sample—7·6 parts per million—was not unusual by comparison with the malting anthracites collected at South Wales Collieries, whereas the arsenic in the malt produced was obviously very much greater than would be expected in the case of malt dried over an anthracite of ordinary composition.

With regard to the large amount of ash and cinder which was obtained from this experiment, Mr. Hervey noted that the anthracite in question was very "soft," and that some of it was a good deal broken up, so that in practice much fell through the bars. Moreover, the anthracite was a bad burning coal and could not properly consume its own "small" and cinders. The kiln in which the experiment was conducted has longer bars to its furnace, and wider spaces between the bars than is usual at most of the kilns of these Newark maltings, and this again afforded a greater opportunity for small coal to escape proper combustion.

SECOND EXPERIMENT, 1903.

The second experiment was carried out at Messrs. Gilstrap, Earp and Co.'s maltings at Newark on April 4th, 1903. It was evidently desirable that in repeating the experiment there should be no doubt as to the sample of anthracite being thoroughly representative, and arrangements were therefore made for Mr. Price, who had obtained considerable experience in sampling anthracite when collecting samples for the Commission at South Wales collieries, to visit Newark and to sample the anthracite used.

On April 4th Mr. Price weighed and sampled the fuel selected, and witnessed the commencement of the kilning on April 5th. Mr. R. B. Floris, who has been engaged with Dr. McGowan in the examination of anthracite samples for the Commission, went to Newark on April 8th, when the kilning was about to be completed, took samples of malt, culms, ash, etc., and saw to the weighing. Mr. R. M. Morris and Mr. Hervey, on behalf of the firm, took great trouble in supervising the operations throughout, and in making special arrangements for their being conducted by careful and trustworthy men.

The following are the principal details of this experiment.

Kiln.

The kiln selected was a 30-quarter kiln, built about nine years ago. It differed in certain respects from the kiln used in the first experiment, the main difference being due to alterations made last year in the construction of the furnace, in order to secure better regulation of the draught and economy of fuel.

The malting floor of this kiln is a German wire floor, 33 ft. 6 in. by 23 ft. 10 in., supported on girders. It stands 15 ft. 10 in. from the bottom of the kiln. Above the malting floor the four walls of the kiln rise vertically to 6 ft., and then converge to the air outlet, the throat of which is 15 ft. 9 in. above the malting floor. Below the malting floor is the hot-air chamber, which has brick walls. At the foot of the chamber is the brick tunnel containing the fire. This tunnel is 8 ft. long, and its height inside is 44 in. Its base is formed by the fire-bars, the fire being confined to the front 3 or 4 feet of the tunnel. The breadth of the tunnel at the base is 21 in.; its greatest breadth, just below the arch of the roof, is 34 in. On either side of the tunnel are inlets which can admit air direct to the hot-air chamber, without passing through the tunnel. These inlets are opened when required and regulated by the fireman. There is a large iron dispersing plate between the opening of the tunnel inside the hot-air chamber and the malting floor above.

This kiln had been in use throughout the malting season. The anthracite used during this period had been considered satisfactory, and the malt produced on this kiln had uniformly failed to show arsenical contamination by the Reinsch test used at these maltings.

Sweeping of kiln before experiment.—On April 4th the fire having been let out, a number of men were employed all day in sweeping down every part of the kiln and furnace, including the girders beneath the malt floor and all corners in which dust might lodge. After the sweepers had been

over it several times, and had removed several bags full of kiln dust, a final sweeping was given which resulted in the collection of an additional quantity—a few pounds—of dust. The walls of the hot-air chamber were then lightly sprinkled over with water, the malting floor was given a final polish, and the kiln was closed for the night. In the morning, before the kiln was loaded, the hot-air chamber and malting floor were carefully inspected, and it was found that scarcely any dust was perceptible.

Anthracite used, and its Sampling.

The anthracite taken for the experiment was part of a truck load which Messrs. Gilstrap and Earp had received this season from a South Wales colliery. The coal in question, when burnt on another kiln at these maltings, had been found to produce contamination of malt which was perceptible by the Reinsch test, and this truck load had consequently been set aside.

It consisted mainly of large masses such as are usually preferred for malting, together with some smaller pieces. Small patches or streaks of what appeared to be impure coal or black pyrites were to be observed here and there in the coal.

About 1¼ tons was taken to the kiln and weighed. After the larger lumps had been broken the whole was spread out over the brick floor of an adjoining store.

In sampling, Mr. Price divided the bulk into three portions :—

(1) Larger or smaller pieces of coal showing obvious streaks of impure coal or evidence of pyrites on the surface ..	152 lbs.
Remainder consisting of—	
(2) Larger lumps, over 4-inch cube ..	1,627 lbs.
(3) Smaller pieces, under 4-inch cube ..	1,016 lbs.
Add remnants from sampling	54 lbs.
Total weight set aside for burning in kiln ..	2,849 lbs.

In the case of (1) and (3), samples were obtained by systematically reducing the bulk and breaking up the coal. In the case of (2), numerous small pieces were broken off the large lumps, mixed together, and sampled. In all, three separate samples were obtained, each made up by combining representative samples of (1), (2) and (3) in proportion to the weights above given. This method of sampling was adopted in order to ensure (*a*) that a correct proportion of the visible pyrites in the coal should be obtained in the samples ; and (*b*) that the coal left should be in a condition suitable for use in the kiln.

Kilning.

On April 5th the kiln fire was lighted at 7 a.m. The fire was started with wood, the twigs of three besoms being sufficient. The kiln was loaded at 9 a.m., the depth of the barley on the malting floor being then about 10 inches. The grain used was English barley, which had been kiln-dried before steeping. A sample was taken, which Dr. McGowan found to be free from arsenic. The whole kilning was then carried on in the ordinary manner. The firing was kept under careful supervision, to ensure that the larger and smaller pieces of the anthracite were used up in proper proportion, and to make certain that none of the ash should escape collection. The space below the firebars was raked out from time to time and the cinders and ashes riddled into a large iron skip through a riddle of about ½-inch mesh. What did not pass through the riddle was returned to the fire. In this way the fuel was more completely burnt than would usually be the case, as ordinarily a half-inch riddle is employed. When the malt was taken off the floor, at 3 p.m. on April 8th, 313 lbs. out of the 2,849 lbs. of anthracite had not been used. The temperature of the malt during the kilning was taken every two hours. Mr. Hervey stated that in view of the temperatures and also of his analysis of the malt, he considered that the heating had been effected in a regular and satisfactory manner.

Weighing and Collection of Samples at end of Experiment.

Malt.—The malting floor was unloaded by passing the malt through a hopper, and thence by means of shoots to an elevator, which discharged the malt into a revolving drum screen. This screen separated the bulk of the culms, which fell through its meshes and were collected below. The screened malt passed by other shoots and a second elevator to a floor in the malt house, where it was discharged over a flat screen, which separated a small quantity of culms and of husks that had been detached from the malt in the screening process. Before the malt left the kiln, the shoots, elevators and screens were thoroughly brushed down to remove dust or malt from previous kilnings.

Samples of the screened malt were taken from the foot of the flat screen. The discharge of malt over this sieve went on evenly for nearly 1½ hours, and every few minutes small samples were taken ; these samples were mixed in a bushel measure and made a final sample of about 5 lbs.

When this was done the malt was put into sacks and weighed. Including a little additional malt taken out at the foot of the elevator, the total weight of malt was 10,390 lbs.

Culms.—The culms were swept from below the revolving screen ; what had collected beneath the flat screen was added, and the bulk, weighing 390½ lbs., was sampled by successive quartering.

Ash, etc., from kiln fire.—When the malt was taken off, a large iron skip was nearly full of ashes, resulting from the riddling mentioned above. The fireman claimed that this residual ash had been kept to the smallest practicable limits by careful attention to firing. As soon as the malt had been taken off, the fire was let out, and all residue in the furnace was collected and riddled over the skip containing the ashes. What did not go through the riddle was either "cinder"—i.e., partly-burnt coal—or "dross," harder masses consisting of residue which had fused and resembled clinker in appearance.

The weights were as follows :—

Cinder - - - - -	46 lbs.
Ash - - - - -	65½ ,,
Dross - - - - -	38½ ,,
Total residue -	150 lbs.

In sampling, the cinder was broken down to pass through a ¼-inch riddle, and was sampled by successive quartering and crushing. The ash was also sampled by successive quartering, and a representative sample of mixed cinder and ash was taken in proportion to the above weights.

The dross was sampled separately : it was broken roughly, and half was taken and crushed till it all went through the riddle. This was then reduced by successive quartering.

Kiln Dust.—The sides and bottom of the hot air chamber (including the arch of the tunnel and the top of the iron disperser) were swept down. A small amount of dust remained on the top of the girders which was not removed. The weight of the dust collected, which consisted mainly of rootlets, was 164½ lbs. A sample of this was taken by quartering.

The chemical results obtained in this second experiment are shown in the second part of Table VIII.

Appendix 30.

APPENDIX, No. 30—*continued.*

TABLE VIII.—Showing Results of Two Experiments at Malt Kilns at Newark.

First Experiment (1902).

——	Pounds weight represented by sample.	Arsenic. Parts per million. Total.	"Fixed."	Volatile.	Grains per lb. Total.	"Fixed."	Volatile.	Calculated amount of arsenic present in the total weight in grains. Total.	"Fixed."	Volatile.
Anthracite consumed	2,590	7·6	6·4	1·2	·0532	·0448	·0084	137·8	116·0	21·8
Cinder	331	8·0	6·8	1·2	·056	·0476	·0084	18·5	15·8	2·8
Ash	557	33·0	21·0	12·0	·231	·147	·084	128·7	81·9	46·8
Dross	13½	12·8	9·0	3·8	·089	·063	·026	1·2	·8	·4
Total residue after combustion.	901½	–	–	–	–	–	–	148·4	98·5	49·9
Malt produced	11,004	2·22	–	–	·016	–	–	176·0	–	–
Culms from malt	363	6·60	–	–	·046	–	–	16·7	–	–
Malt and culms together.	11,367	–	–	–	–	–	–	192·7	–	–

Second Experiment (1903).

——	Pounds weight represented by sample.	Arsenic. Parts per million. Total.	"Fixed."	Volatile.	Grains per lb. Total.	"Fixed."	Volatile.	Calculated amount of arsenic present in the total weight in grains. Total.	"Fixed."	Volatile.
Preliminary.										
"Dust" from previous kilnings, result of repeated and thorough sweeping of kiln before experiment:										
(1) Sample from large bulk.	—	48·00	–	–	0·336	–	–	–	–	–
(2) Sample of final sweepings.		183·33	–	–	1·28	–	–	–	–	–
Anthracite used in experiment, original weight 2,849 lbs., less 313 lbs. unused (3 separate samples):										
(1)	2,536	24·00	21·00	3·00	0·168	0·147	0·021	426·0	372·8	53·3
(2)		15·00	12·14	2·86	0·105	0·085	0·020	266·3	215·6	50·7
(3)		18·33	15·00	3·33	0·128	0·105	0·023	324·6	266·3	58·3
Mean		19·11	16·05	3·06	0·134	0·112	0·021	339·8	284·0	53·3
Materials collected at end of experiment:										
Malt	10,390	0·60	–	–	0·0042	–	–	43·6	–	–
Culms	390½	3·00	–	–	0·021	–	–	8·2	–	–
"Dust" (principally rootlets and culms) from kiln—single light sweeping.	Over 164½	10·14	–	–	0·071	–	–	Over 11·7	–	–
Cinder and ash	111½	11·67	10·00	1·67	0·082	0·070	0·012	9·1	7·8	1·3
"Dross"	38½	5·71	5·00	0·71	0·040	0·035	0·005	1·5	1·3	0·2

OBSERVATIONS.

It will be seen from the results (Table VIII.) that both experiments failed to indicate anything like an equation between the arsenic in the fuel used, and the arsenic in the materials obtained at the end of the kilning. And the failure was of an opposite kind in the two experiments. In the first, according to the calculations, the malt produced, and the ash which was left, each contained a greater weight of arsenic than that which had been estimated to be present in the fuel. In the second, according to the calculations, only a small proportion of the arsenic present in the fuel was recovered in the malt, culms, and ash.

Nevertheless, it has been thought worth while to place the results on record, as illustrating the complexity of the question, and the danger of generalising from isolated experiments on a malt kiln, however carefully conducted.

The following probably influenced the results obtained in Experiment I. :—

(*a*) The kiln had been in continuous use throughout the season, and, though the furnace was swept thoroughly, the deposit on the large hot air chamber beneath the malting floor was left undisturbed. Hence some of the arsenic in the malt may have been derived from volatilisation of arsenic deposited on the walls of the hot air chamber as a result of previous burnings during the season. (Compare Mr. Baker's observations, Q. 10683.)

(*b*) The anthracite used was known, as a result of previous kilnings, to be unsatisfactory as regards arsenic, although this was not shown by the sample analysed. It is quite likely that this sample was not representative. On the other hand, proper sampling in the case of the cinders, ash, "dross," and malt was a matter of much less difficulty, and probably the samples here were representative.

The following probably influenced the results obtained in Experiment II. :—

(*a*) The combustion was much more thorough than is ordinarily practised, the whole of the fuel being burnt to a relatively small amount of fine ash.

(*b*) The preliminary thorough sweeping of all the parts of the kiln (including the final sweeping of the walls of the hot air chamber beneath the malting floor, which removed dust containing 180 parts of arsenic per million) must have materially influenced the results. In the first place, there was no opportunity of the malt becoming contaminated by arsenic derived from previous kilnings; in the second place, the sweeping involved the kiln fire being out for some twenty-four hours, and hence the walls of the kiln were cooler than usual and probably condensed more arsenic.

(*c*) The sample of kiln dust obtained on completion of the kilning was the result of a single superficial sweeping. The sweepings consisted principally of malt culms, and would not contain all the arsenic which had been deposited on the interior surface of the heating chamber, still less that which had been condensed in its porous walls.

(*d*) There was no doubt some loss of arsenic in the various shoots and elevators, which detached culms and portions of the husk. This was not the case in Experiment I., where the malt did not go through elevators and was screened by hand.

The influence of the above conditions, however, must remain a matter of mere surmise. But it should be noted that in the second experiment, whatever may have been the ultimate destination of the arsenic originally present in the fuel, there can be no question that the samples of fuel and of ash were as representative as it was possible to make them, or that the weighings were accurate in each case. The results of analysis of these samples are instructive, as they show that very little arsenic, comparatively speaking, remained behind in the ash. The extreme difficulty of accurate sampling in the case of a "bad" anthracite containing numerous streaks of black pyrites is also brought out by this experiment. The analyses of the three separate samples of the fuel used show a fairly close correspondence, both as regards "total" and "volatile" arsenic, but the correspondence is less exact than might perhaps have been anticipated in view of the great care which was taken in sampling. It should be added that the anthracite in question was of a kind which on inspection would at once be recognised as unsatisfactory by any one aware of the necessity of looking for granular black pyrites in anthracite specimens.

Appendix 31.

APPENDIX 31.

REPORTS ON BERI-BERI.

REPORTS ON INQUIRIES AND CHEMICAL EXAMINATIONS MADE FOR THE COMMISSION REGARDING THE RELATION OF BERI-BERI TO ARSENICAL POISONING.

SECTION I.—GENERAL ACCOUNT OF INQUIRIES AND SUMMARY OF RESULTS.

In their evidence regarding the character of the illness met with during the beer poisoning epidemic of 1900, Dr. Reynolds, Dr. Kelynack, and others drew attention to a general similarity said to exist between this illness and the disease beri-beri. The resemblance in question was said to be most marked in cases of beer poisoning characterised by well-marked peripheral neuritis and affections of the heart. Comparison was made, not only with descriptions of beri-beri as met with in tropical countries, where it is frequently endemic or epidemic, but also with comparatively recent outbreaks of this disease in the Richmond Asylum, Dublin, in 1894, 1895, and 1897. An account of these outbreaks, by Dr. Conolly Norman,* illustrated by photographs, showed a striking clinical resemblance between these cases and the bulk of those met with at the end of 1900 in the Poor Law Infirmaries at Manchester and Liverpool, as a consequence of arsenical beer poisoning.

Major Ronald Ross, C.B., F.R.S., Lecturer in Tropical Medicine at University College, Liverpool, who had seen a number of the arsenical cases in 1900, wrote to the Commission that in his view the difficulty in distinguishing these cases from the "dry" forms of beri-beri was very great, and he gave other particulars regarding the uncertainty which prevails regarding the origin, nature and cause of this disease.

In his later evidence, on March 7th, 1902, Dr. Reynolds gave an account of some further inquiries which had led him and Major Ross to conclude that the existence of a causative relation between arsenic and tropical beri-beri was possible or probable. (Q. 8379–8401.)

In view of these considerations the Commission decided that it was desirable to obtain some further knowledge on this subject. The suggestion that arsenic might be concerned with beri-beri was, however, new; scarcely any chemical examinations had been made to test it, and it seemed to the Commission advisable, therefore, to institute some preliminary inquiries, along with chemical examinations, in order to determine how far, for their purpose, it was necessary to make further investigations.

Beri-beri is met with comparatively rarely in this country, but cases occasionally come to notice at British ports in vessels arriving from foreign. Such cases usually fall into two classes:—

(1) Indians, Chinese, Lascars, and others employed on steam ships trading with Eastern and tropical ports.

(2) Europeans on board sailing ships which arrive at the end of long voyages (usually many months) from almost any part of the world. Among sailing ships arriving at English ports, Scandinavian vessels appear exceptionally prone to be attacked by beri-beri. Many of these vessels bring cargoes from South America, and use Falmouth as a port of call, waiting there for orders.

The disease in cases of the second class is generally accepted as identical with the beri-beri which is common in the East; in most of these cases the clinical manifestations seem to be essentially those of "tropical" beri-beri. It should be noted, however, that there is often no evidence that beri-beri was prevalent at the port of departure of these sailing ships. The disease frequently does not appear until the vessel has been many weeks at sea.

Difficulty frequently arises in assigning a definite date or period to beri-beri, as its onset is often extremely gradual. A sailor, for example, may have been ailing for many weeks before he was sufficiently ill to be unable to work, but on giving an account of his illness he will probably date its commencement to the time when he was incapacitated from duty.

Collection of Information and Samples from Ships at Home Ports.

In September, 1901, the Commission communicated with the Medical Officers of Health of the ports of London, Liverpool, Tyne, Hull, Cardiff, Bristol, Plymouth and Falmouth, with the object of obtaining information as to cases of beri-beri which came to notice on the arrival of ships. The Medical Officers in each instance readily undertook to assist the Commission. From September, 1901, to October, 1902, a total of 21 vessels† on which beri-beri had occurred during the voyage were reported to the Commission. None of these arrived at Bristol, Tyne, or Plymouth, 8 arrived at London, 9 at Falmouth (some of which afterwards came to London), 2 at Liverpool, 1 at Hull, and 1 at Cardiff. Much trouble was taken by the Port Medical Officers of Health and their inspectors to supply the Commission with the information asked for, and to obtain samples of food.‡ The vessels so reported are shown in tables below. Table I. relates to 14 vessels from which samples of food stuffs were obtained and examined: the remaining vessels are noted in Table II. The following is a summary of the facts regarding beri-beri on the 14 ships noted in Table I. Twelve of these were Scandinavian sailing ships: two were steamships coming from India or Burmah. The cases on the latter vessels were Lascar or African firemen; all those on the Scandinavian ships, with one exception, were Europeans.

"FRAY." Norwegian barque, 298 tons, arrived Falmouth, September 9th, 1901. Reported by Mr. Cecil Bullmore, Port Medical Officer of Health.

Left Laguna with cargo of logwood 52 days before arrival.

Crew of nine; one case of beri-beri.

Captain of vessel, Norwegian, aged 42. Illness two or three weeks' duration. Captain quartered aft by himself. No illness among rest of crew; no beri-beri on previous voyages.

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* Transactions of the Royal Academy of Medicine in Ireland, Vol. XVII.

† In a few cases the mere fact of the arrival of the vessel was reported, and for one and another reason no details were obtained. These have not been included in the figures given.

‡ On one or two occasions Mr. Hammond Smith, being in the neighbourhood in course of his general food inquiries, assisted in obtaining post-mortem specimens and samples of foods from the ships.

Diet of captain: salt beef and pork, tinned mutton and beef, fish balls*, stock fish*, dried potatoes* and vegetables, lime juice, vinegar, red wine, no spirits, no rice.

"PEGU," ss., 2,511 tons, arrived Liverpool December 10th, 1901. Reported by Dr. Hope.

Left Rangoon with general cargo on November 7th, 33 days on voyage.

Crew of 74 hands, 24 of these being Lascars quartered aft. Four Lascars (all firemen) attacked by beri-beri. Ages from 22-27 years. They had signed on in July, 1901, and since then the ship had made one previous voyage to Liverpool. The four men were quartered with 20 other Lascars in crews' quarters aft; accommodation good and quarters well ventilated and clean. No illness among rest of crew, save a few cases of malaria, one of dysentery, and one of acute rheumatism. No beri-beri on previous voyages; vessel launched only 12 months previously.

First patient consulted surgeon on November 17th, previously four days ill. Other two patients fell ill on November 29th, and the fourth on December 1st. The latter had complained of illness for a fortnight before.

Diet of Lascar firemen attacked: Chief food, rice* from Rangoon. Curries varying from time to time—at one time of mutton, another of fish (Bombay duck*) with chillies, tamarind, coriander and other spices from bazaar, Rangoon. Also "samsu"*—a native drink—and gin*, tea, no lime juice. Tinned meats were never used by the men. Tinned ghee* (native butter) from Rangoon was taken. Dahl (native peas), and fresh beans occasionally used. Drinking water from artesian well at Rangoon, stored in iron tanks. No diet known to have been taken by patients which differed from that of other Lascars on board.

On arrival in Liverpool four cases, considered by Major Ross and others undoubted beri-beri, all had considerable œdema. Ahmed, 27, died in hospital from heart failure, December 15th. Post-mortem, liver*, hair*, brain*, and nails*, obtained. Abid, aged 26, died in hospital from cardiac failure, December 13th. Hookan, 22, slight attack, recovering. Hasan Ali, 26, severe attack, now no œdema, recovering; specimen of hair taken*.

"CIMBRIA," Norwegian barque, 1,000 tons, arrived London, January 15th, 1902. Reported by Dr. Herbert Williams, Medical Officer of Health of the Port of London.

Left Moulmein with cargo of teak, July 31st, 1901, 168 days before arrival. Touched at St. Helena, November 9th, 1901, and Falmouth, January 12th, 1902.

Crew of 12 on departure. Six cases of beri-beri on voyage. W. Lyons, A.B., aged 45, taken ill about August 14th, swollen feet, œdema gradually extended to all parts of body, including head; died November 3rd. L. Weins, a Dane, aged 26, taken ill about October 9th, landed St. Helena Hospital, November 9th, where beri-beri diagnosed. H. Langson, half-caste native of Bombay, aged 19, ill off and on throughout voyage, suffering from swollen legs. On arrival in London had slight œdema of legs, complains of pain in abdomen and back. Three other men who shared the same quarters in the house on deck were slightly ill with swollen legs, but not incapacitated from work on the vessel's arrival at St. Helena. Slight illness, accompanied by swelling of legs, in master, steward, and first officer, who lived in after-house.

Notes on Diet.—Rice* from Rangoon four times a week. Lime juice issued daily after arrival at St. Helena, not before. A little red wine, otherwise no alcoholic liquor. Stock fish* taken on board in Norway, issued and eaten once a week. Flour* issued twice a week. Vinegar, drinking water taken at Moulmein, stored in iron tanks.

"COLLINGWOOD," Norwegian barque, 950 tons, arrived Cardiff, January 24th, 1902. Reported by Dr. Walford and Dr. Hughes.

Left Cape Town June 15th, 1901, arrived Rangoon July 27th, sailed September 11th, 135 days before arrival at Cardiff. Called at St. Helena October 16th.

Four men ill on arrival. H. W., aged 24, carpenter, taken ill about November 30th. H. L. B., aged 52, sail-maker, taken ill about December 24th. S. S., aged 19, and D. P., aged 24, both A.B.'s, taken ill about December 27th. On arrival the men had well-marked paralysis of lower limbs, slight dropsy, loss of patella reflex, and weak action of the heart, but all seemed to be recovering. The carpenter and sail-maker slept by themselves and apart from the rest of the crew; the other men were in the forecastle. Captain states that there were no other cases of illness during voyage. No beri-beri on previous voyages.

Notes on Diet.—The Captain states that the men drank beer and spirits freely in Rangoon. The food on the voyage consisted mainly of tinned meat, dried fish,* dried potatoes,* peas, and flour.* No rice on voyage, but rice taken at Rangoon. No alcohol during whole voyage except two bottles of whisky.

Some samples of hair from these cases were examined by Dr. Savage, of Cardiff, who found distinct evidence of arsenic. Samples of hair were also sent to the Commission, but they were not sufficiently large to enable a satisfactory determination of arsenic to be made. Dr. Savage also tested certain samples of food and water for arsenic, but without affirmative result.

"ARGO," Norwegian barque, arrived Goole, April 6th, 1902, reported by Dr. Mason, Medical Officer of Health of the Port of Hull.

Left Cape Haytien (Hayti) February 22nd, with cargo of logwood. Jon Jansen, 47, carpenter, living on board vessel for nine months, taken ill after leaving Hayti, but symptoms of illness believed to have begun about a fortnight before the ship's departure. Had suffered from "pins and needles" in palms and soles and œdema. On arrival could hardly walk, owing to loss of power in limbs; no knee jerks, slight œdema above ankles. Skin of soles of feet rough, no pigmentation, save in parts exposed to weather. Hair specimen taken. No illness among rest of crew, numbering 11.

His diet included dried codfish,* tinned fish,* tinned meat, dried vegetables,* potatoes, rice,* in small quantity. Sample of drinking water* obtained.

"BEN MORE," Norwegian sailing ship, arrived Falmouth April 15th, 1902. Reported by Mr. Cecil Bullmore.

Left Nicaragua with cargo of cedar and mahogany 167 days before arrival.

Crew of 20, including three officers. One case of beri-beri: E. Liennigh, first mate, aged 46. Had joined ship in Liverpool three years ago. Was taken ill three weeks after leaving Nicaragua. On arrival, partial paralysis of both legs; knee jerks absent, œdema of both feet and legs, extending to abdomen and thorax; heart irregular, slight desquamation of soles of feet; no catarrhal symptoms, no pigmentation.

Notes as to Diet.—Monday: Salt meat in cold weather, rice* porridge in hot weather. Tuesday: Tinned meat* or soup, preserved potatoes and mixed preserved vegetables.* Wednesday: Salt fish* and potatoes. Thursday: As Tuesday. Friday: Salt meat and beans. Saturday: Salt fish, soup, sago, and preserved fruit. Sunday: As Tuesday, with pudding. Bread or biscuit, butter, tea, coffee, and condensed milk at other meals. Lime juice* regularly. Water,* from cement tanks—washed 16 months ago in Newcastle.

"CHARLES RACINE," Norwegian sailing ship, about 2,000 tons, arrived London, March 16th, 1902. Reported by Dr. Herbert Williams.

* Samples obtained and sent to Commission

Appendix 31.

Left Fremantle, Australia, November 30th, 1901, 105 days before arrival. Touched at St. Helena January 21st.

Crew of 15 hands. Six cases of beri-beri: Cornelius Fortensen, 68, joined ship November 27th, working passage home. Taken ill January 17th, 1902; O. Stanisland, carpenter; G. Fagerstrom, sail-maker; J. Gabriel, A.B.; A. Valstrom, A.B.; J. Eliasen, A.B., all Norwegians, who joined ship in Norway. Taken ill at different dates between January 5th and 18th. All six cases landed at St. Helena. Cornelius Fortensen died there January 22nd. No other illness amongst crew.

Notes on Diet.—Rice * about once a week, salt fish,* tinned meat,* lime juice * when no fresh vegetables to hand, no alcoholic liquors, drinking water in iron tanks.

"PRINCE GEORGE," Norwegian barque, 474 tons, arrived London, April 18th, 1902. Reported by Dr. Herbert Williams.

Left Port Victoria (Seychelles) October 23rd, 1901, with cargo of guano.

Crew of 10. Three cases of beri-beri: G. Carlsen, Norwegian mate, 27; Carl Hansen, Swede, A.B., 28; Franz Biji, Norwegian, O.S., 22. All taken ill about January 14th, 1902. On arrival, G. Carlsen and Carl Hansen on duty, the first has œdema of right arm and leg, no pigmentation, gums spongy; the second has both legs swollen from knee to ankles. Franz Biji seriously ill, whole body much swollen. Died on April 17th. Post-mortem (Stratford Infirmary, April 21st). Brawny œdema of legs and chest, veins engorged, heart enlarged, and the walls thinned, valves healthy. Fluid in pleura and peritoneum, spleen engorged, kidneys appear healthy. Case seen by Dr. Ross, of London School of Tropical Medicine, considered to be undoubtedly beri-beri.

Carlsen was berthed in quarters with master and steward, the two other cases were berthed in the forecastle with five others of the crew. No evidence of their diet having differed from that of their companions.

Notes on Diet.—Said to have been good supply of food throughout voyage. Salt pork and salt beef, potatoes, tinned mutton,* no dried fish, as supply had given out before leaving Port Victoria, Norwegian tinned fish,* rice * bought on outward voyage at Port Louisa taken moderately, lime juice * taken moderately, drinking water * obtained at Port Victoria, stored in iron tanks.

"SOMALI" (ss.), 8,000 tons, arrived London May 15th, 1902. Reported by Dr. Herbert Williams.

Left Calcutta with general cargo, April 12th, 1902.

Crew of 171. Two cases of beri-beri among African firemen, A. and B., quartered in forecastle with 15 others. Date of A.'s attack not known; he died April 25th. B., aged 26, fell ill on April 10th. He had joined the ship in London for outward voyage. On arrival showed œdema, weakness, and loss of power in lower limbs; no knee jerks, slight dropping of toes. No beri-beri on previous voyages of "Somali."

Notes on Diet.—Mainly rice,* curry,* dahl, and fish.* No alcoholic liquor.

"SORATA," Norwegian barque, arrived Falmouth June 3rd, 1902. Reported by Mr. Cecil Bullmore.

Left Punta Arenas (Chili) January 2nd, 1902, 152 days before arrival.

Crew of 12, including three officers. Five cases of beri-beri. Captain (Norwegian, aged 45): Illness began about four months after leaving Punta Arenas. On arrival showed œdema, well-marked paralysis of legs, weakness of arms, great muscular tenderness, dyspnœa; probably fluid in pericardium; had an attack of beri-beri six years ago. First mate (Norwegian, 33): Fell ill about four months after leaving Punta Arenas. On arrival œdema, slight paralysis, and great weakness; marked tenderness of muscles of legs; no recent pigmentation; some "sea-boils." Second mate (Norwegian, 49) also taken ill about the same time as captain and first mate. On arrival slight œdema, no definite paralysis, muscular tenderness, no pigmentation. Steward (Norwegian, 31), slight œdema, loss of power in right leg, muscles tender, no pigmentation. Carpenter (Norwegian, 29): Date of onset of illness not stated; on arrival showed œdema of legs and abdomen, loss of power in legs, muscular tenderness; seemed very ill.

Others of crew complained of feeling ill, but no indications of beri-beri. Sanitary condition of vessel very bad; forecastle dirty, closets filthy, ventilation of forecastle and cabins bad; one not lighted.

Notes on Diet.—Provisions have been short. Usual diet, including officers:—Monday: Milk, soup, and fish. Tuesday: Pea soup and salt meat. Wednesday: As Monday. Thursday: Salt or meat and tinned vegetables (tomatoes,* cabbage, etc.). Friday: Bean soup. Saturday: As Monday. Sunday: Preserved meat and dough; also oatmeal, sugar, lime juice,* barley, flour, rice,* drinking water dirty; iron tank needed cementing.

"MORGENGRY," Norwegian barque, arrived Falmouth June 3rd, 1902. Reported by Mr. Cecil Bullmore.

Left Santos March 11th, with a cargo of coffee, 84 days before arrival.

Crew of 11, including three officers. Two cases of beri-beri. Barbadoes negro, aged 19, fell ill two weeks after leaving Santos; died just before arrival; believed to have been beri-beri from symptoms reported by captain. Post-mortem, June 5th: Slight œdema of face and legs; veins engorged; small amount of fluid in pleura; blood very dark and fluid; heart enlarged, walls of ventricles thin; much fluid in pericardium; spleen and kidneys appeared normal; congestion of vessels at base of brain and of spinal cord noted; much fluid in membranes of cord. Jacob Neilson (Dane, aged 18) taken ill one month after leaving Santos. On arrival showed loss of power, symptoms of dilatation of heart, œdema of legs, abdomen, and chest. Both cases slept in forecastle with three others. Forecastle was clean; its ventilation not good.

Notes on Diet.—The following were usual:—Monday: Fish balls,* preserved potatoes, soup. Tuesday: Pork or tinned meat or fish, boiled rice.* Wednesday: Stock fish,* and preserved potatoes. Thursday: Tinned meat or fish, vegetable soup, balls of dough. Friday: Salt pork or beef, no vegetables. Saturday: Pancakes, pork, porridge. Sunday: Tinned meat, sago and potato soup, dried fruit. Lime juice. Bread half the week, biscuits the other half.

"HANDEL JUST," Norwegian barque, arrived Falmouth May 31st, 1902. Reported by Mr. Cecil Bullmore.

Left Bahia (Brazil) March 29th, 1902, with cargo of iron ore, 63 days before arrival.

Crew of 14. Two cases of beri-beri, both able seamen. Friedrichsen (Dane, 19), joined ship in Denmark eight months before. Illness began a month before arrival. Closter (aged 60) joined the ship at Cardiff. Illness began a fortnight before arrival.

Symptoms in both cases on arrival: Shortness of breath, no appetite, malaise, œdema of legs and feet, pains in calves of legs, no pigmentation. Friedrichsen had slight ankle drop. Closter attacked by beri-beri eight years ago. Both slept in forecastle; ventilation very bad.

Notes as to Diet.—Food has run short; crew lived on bread and butter for last week. Previously diet was beans, potatoes, salt or tinned

* Samples obtained and sent to Commission.

meat, dried fish, fishballs, rice, apples. No lime juice taken by anyone, though plenty on board.

"H. C. RICHARDS," Norwegian sailing ship, 765 tons, arrived London June 30th, 1902. Reported by Dr. Herbert Williams.

Left Port of Spain with cargo of pitch April 25th, 1902, 66 days before arrival.

Crew of 12. One case of beri-beri. Norwegian seaman, 26. Had joined ship at Barbadoes, March 22nd; fell ill June 16th, 1902. Both legs swollen from ankle to knee, vomiting, shortness of breath, unsteadiness in walking. Diagnosed beri-beri on arrival. Quartered in forecastle with seven others. No illness in rest of crew, save one slight case of ague (?). On previous voyage of this ship, leaving Madagascar November 16th, 1901, three fatal cases of beri-beri occurred (the captain and two seamen).

Diet of beri-beri case the same as rest of crew. Included small quantity of rice,* no alcoholic liquor, salt and tinned beef,* tinned fish, fishballs.

"VICTOR," Norwegian barque, arrived London August 8th, 1902. Reported by Dr. Herbert Williams.

Left Moulmein with a cargo of teak, March 6th, 1902, 155 days before arrival; called at Ponta Delgada, Western Islands, July 17th-25th. Appendix 31.

Crew of 10. Three cases of beri-beri. Campbell (Canadian A.B., 50) joined vessel at Moulmein; sick and off duty nearly all the passage; could not go aloft owing to weakness and swollen feet. J. Jonson (Swede, A.B.), taken ill about July 8th, swollen legs and feet; treated at shore hospital in Delgada on July 17th for beri-beri; able to rejoin July 24th. W. Hubner (O.S., 20), ill and suffering from swollen feet since July 25th. All three cases recovering on arrival in London. They were quartered in house on deck with three other men. No other cases of illness during voyage; no beri-beri on previous voyages.

Notes as to Diet.—Rice* obtained at Moulmein served out three times a week to all members of crew. Flour* obtained at Moulmein in March, 1902, made into bread daily. Dried fish* obtained in Cape Town December, 1901, eaten twice weekly. No lime juice or acid drink or any alcoholic liquor used. Drinking water stored in iron tanks.

* Samples obtained and sent to Commission.

APPENDIX, No. 31—*continued.*

TABLE I.

VESSELS ON WHICH BERI-BERI WAS REPORTED AND FROM WHICH SAMPLES OF FOOD, &c. WERE EXAMINED FOR ARSENIC.

Vessel.	Tonnage.	Port of Departure.	Port of Arrival.	Date of Departure.	Date of Arrival.	Number of Days on Voyage.	Cases of Beri-beri during Voyage.		Nationality of Beri-beri cases.	Cases of Beri-beri on or after Arrival.		Number of Days on Voyage before illness of first case occurred.*	Whether cases of Beri-beri on previous Voyage.
							Total Number.	Number of Fatal on Voyage.		Total Number.	Number Fatal.		
	Tons.												
"Fray" (Norwegian barque).	298	Laguna	Falmouth	19 July 1901	9 Sept. 1901	52	1	–	Norwegian	1	–	About 4 weeks	No.
"Pegu" (Steamship)	2,511	Rangoon	Liverpool	7 Nov. 1901	10 Dec. 1901	33	4	–	Lascars	4	2	About 6 days	No.
"Cimbria" (Norwegian barque).	1,000	Moulmein	London	31 July 1901	15 Jan. 1902	168	6	1	1 British, 1 Dane, 1 native of Bombay; 3 not stated.	4 (3 slight)	–	About 14 days	Not known.
"Collingwood" (Norwegian barque).	950	Rangoon	Cardiff	11 Sept. 1901	24 Jan. 1902	134	4	–	3 Norwegian, 1 Russian Fin.	4	–	About 7 weeks	No.
"Argo" (Norwegian barque).	?	Cape Haytien (Hayti).	Goole	22 Feb. 1902	6 April 1902	43	1	–	Norwegian	1 (recovering)	–	A fortnight before departure, whilst living on vessel.	Not known.
Ben More" (Norwegian barque).	?	Nicaragua	Falmouth	29 Oct. 1901	15 April 1902	167	1	–	Norwegian	1	–	3 weeks	Not known.
"Charles Racine" (Norwegian sailing ship).	2,000	Fremantle, Australia (*via* St. Helena, where cases landed).	London	30 Nov. 1901	16 Mar. 1902	106	6	1	Norwegian	–	–	5 weeks	Not known.
"Prince George" (Norwegian barque).	474	Port Victoria (Seychelles).	London	23 Oct. 1901	18 April 1902	177	3	–	2 Norwegian, 1 Swede.	3	1	12 weeks	Cases in 1899.
"Somali" (Steamship)	8,000	Calcutta	London	12 April 1902	15 May 1902	33	2	1	African	1	–	? Disease beginning at date of departure.	No.
"Sorata" (Norwegian barque).	?	Punta Arenas	Falmouth	2 Jan. 1902	3 June 1902	152	5	–	Norwegian	5	–	16 weeks	Not known.
"Morgengry" (Norwegian barque).	?	Santos	Falmouth	11 Mar. 1902	3 June 1902	84	2	–	1 African, 1 Dane	2	1	2 weeks	1 case in 1901.
"Handel Just" (Norwegian barque).	?	Bahia (Brazil)	Falmouth	29 Mar. 1902	31 May 1902	63	2	–	Scandinavian	2	–	5 weeks	Not known.
"H. C. Richards" (Norwegian sailing ship).	766	Port of Spain	London	25 April 1902	30 June 1902	66	1	–	Norwegian	1	–	7 weeks	3 cases on last voyage (1901).
"Victor" (Norwegian barque).	?	Moulmein	London	6 Mar. 1902 (called at Ponta del Garde, 17th to 25th July).	8 Aug. 1902	155	3	–	1 Canadian; 1 Swede; 1 not stated.	3 (recovering)	–	18 weeks	No.

* As to this, however, *see* observations on page 326.

TABLE II.

OTHER VESSELS ON WHICH BERI-BERI WAS REPORTED.

Vessel.	Tonnage.	Port of Departure.	Port of Arrival.	Date of Departure.	Date of Arrival.	Number of Days on Voyage.	Cases of Beri-beri during Voyage.		Nationality of Beri-beri Cases.	Cases of Beri-beri on or after Arrival.		Number of Days on Voyage before illness of first case occurred.	Whether Cases of Beri-beri on previous Voyages.
							Total Number.	Number of Fatal on Voyage.		Total Number.	Number Fatal.		
	Tons.												
"Felix" (Norwegian barque).	288	Laguna	Falmouth	1 Oct. 1901	5 Dec. 1901	65	1	–	Norwegian	1	–	2 weeks	No.
"LIV." (Norwegian barque).	?	Sidney	Falmouth	24 Aug. 1901	24 Dec. 1901	122	2	–	Norwegians	2	–	9 weeks	No.
"Ulysses" (British steamship).	2,281	Yokohama	Liverpool	2 Oct. 1901	13 Dec. 1901	72	2	1	Chinese	1	1	5 weeks	One fatal case nine months previously.
Araura" (Norwegian barque).	?	Costa Rica	Falmouth	7 July 1901	24 Dec. 1901	170	5	1	1 Englishman, 3 Norwegians, 1 Russian Fin.	4	–	16 weeks	Not known.
Habil" (Danish barque).	?	Laguna	Falmouth	21 Nov. 1901	1 Feb. 1902	71	1	–	Russian Fin	1	–	7 weeks	Not known.
Rome" (British steamship).	5,545	Sydney	London	11 Jan. 1902	24 Feb. 1902	43	2 (1 landed at Aden.)		1 Punjabee, 1 native fireman (nationality not stated).	1	–	24 days	Not known.
Murex" (British steamship).	?	Singapore	London	29 Aug. 1902	29 Oct. 1902	61	1	1	Chinaman	–	–	7 weeks	No.

APPENDIX, No. 31—*continued.*

TABLE III.

EXAMINATION FOR ARSENIC OF SAMPLES OF FOOD FROM THE 14 VESSELS NOTED IN TABLE I.

(Fractions of a grain arsenious oxide per lb.)

	Fray.	Pegu.	Cimbria.	Collingwood.	Argo.	Ben More.	Chas. Racine.	Prince George.	Somali.	Sorata.	Morgengry.	Hanslel Just.	H. C. Richards.	Victor.	TOTAL.
Dried fish	$\frac{1}{80}$	$\frac{1}{80}$ (Bombay duck).	$\frac{1}{180}$	$\frac{1}{300}$	$\frac{1}{75}$	$\frac{1}{200}$	$\frac{1}{440}$	—	$\frac{1}{150}$	—		—	—	$\frac{1}{170}$	10
Tinned fish	—	—	—	—	trace	—	—	trace	—	—	0	—	—	—	3
Tinned meat and vegetables	—	—	—	—	—	$\frac{1}{250}$	—	trace	—	Tomatoes, 0 Cabbage, trace.	—	—	—	—	4
Tinned milk	—	—	—	—	—	—	—	0	—	—	—	—	—	—	1
Fish balls	0	—	—	—	—	—	—	—	—	—	—	—	trace	—	2
Dried potatoes	$\frac{1}{50}$	—	—	trace	—	—	—	—	—	—	—	—	—	—	2
Dried apples or vegetables	—	—	—	—	trace	—	—	—	—	—	—	—	—	—	1
Flour	—	—	—	0	—	—	—	—	—	—	—	—	—	—	1
Drinking water	—	—	—	—	0	—	—	—	—	0	trace	0	—	—	4
Lime juice	0	—	—	—	—	trace	—	0	—	0	0	—	—	—	5
"Samsu"	—	trace	—	—	—	—	—	—	—	—	—	—	—	—	1
Gin	—	0	—	—	—	—	—	—	—	—	—	—	—	—	1
Rice	—	$\frac{1}{740}$	—	—	trace	0	—	trace	$\frac{1}{300}$	trace	$\frac{1}{700}$	—	0	0	9
Sugar	—	—	—	—	—	—	—	—	—	—	—	0	—	—	1
															45

Trace in each column = below $\frac{1}{1000}$ grain per lb.

EXAMINATION FOR ARSENIC OF FOOD SAMPLES FROM THE ABOVE VESSELS.

Appendix 31.

In the above list of vessels on which beri-beri occurred, the articles of food which were obtained by the Port Medical Officers of Health and transmitted to the Commission have been indicated by an asterisk. It is, of course, evident that the foodstuffs remaining on board a vessel when it puts into port at the end of a long voyage are not necessarily representative of the diet actually taken by the crew during the voyage. In some instances the Port Medical Officer of Health, in transmitting the samples, has noted that usual foodstuffs, such as dried vegetables or tinned meats, had all been consumed, and no specimens were obtainable. This was the case in several of the Norwegian vessels. Mr. Cecil Bullmore notes, in a memorandum on beri-beri made in 1902 to the Falmouth Port Sanitary Authority (a copy of which he has sent to the Commission), that as regards Norwegian ships "the whole arrangements for a voyage seem to be cut down to the hour, and if they are a few weeks overdue owing to contrary winds this becomes most apparent."

Nevertheless, the samples obtained from the ships as a whole covered a considerable range of substances, such as preserved and dried foods, which are used to a greater extent on ship board than on shore. The majority of these have now been examined for arsenic in Dr. McGowan's laboratory, with the results shown in his reports in Section II. below, and also in the Table III. above. Two food materials, rice and fish, were always sent for examination when available, in view of various statements which have been made regarding possible causative relations—apart from arsenic—between use of these foods and beri-beri.

It is noteworthy that *rice* has not formed an important article of diet on some of the Norwegian vessels: in two instances no rice at all was taken. On the other hand, in the s.s. "Pegu" and "Somali," where the sufferers were Lascars or African firemen, rice was the main article of food. No arsenical contamination—save to a minute extent—was, however, detected in the rice samples obtained from any of the vessels.

With regard to *fish*, it will be seen that neither of the two specimens of fish balls (fresh fish dried and powdered and mixed with flour), nor any of the three samples of tinned fish, contained more than the merest trace of arsenic. Dried fish, on the other hand, habitually contained arsenic, in varying amounts up to 1-80th grain per lb. In most instances the fish was dried cod, obtained in Norway. Large stores of this fish are usually carried in Norwegian sailing ships. According to information supplied by Professor Uchermann, of Christiania, this fish is cured by drying in the sun, and not by smoking over fuel. The origin of the arsenic is perhaps to be sought in the subsequent salting, possibly in preservatives used,* but no authoritative information has been obtained by the Commission on this point.

Tinned meat and tinned vegetables were examined for arsenic in four instances, tinned milk in one case, lime-juice in five cases, drinking water (on account of its storage in iron tanks) in four instances, all with negative, or practically negative, results. 1-90th grain of arsenic per lb. was found in one sample of "dried potatoes"—*i.e.*, potatoes which have gone through some process of drying or curing after being cut up in slices. Possibly here preservatives may again afford an explanation.

In view of the evidence that cheap cocoa containing oxide of iron may be contaminated by arsenic (Hehner, Appendix 27; H. Smith, Appendix 24) it is unfortunate that no samples of cocoa were obtained, particularly as cocoa is sometimes taken largely by sailors. The fact that notable amounts of arsenic may be found in cocoa of this kind was ascertained only after these inquiries had been completed.

EXAMINATION FOR ARSENIC OF SPECIMENS FROM FATAL CASES OF BERI-BERI, AND OF HAIR OF BERI-BERI CASES.

In three instances the Commission was informed of deaths from beri-beri among the cases reported in Table I. above, and at post-mortem examinations some of the organs were obtained and sent to the Commission. In each of the three cases the liver was examined in Dr. McGowan's laboratory, and in two cases the brain also was tested for arsenic. The results are given in Table VI. below, together with the results of testing for arsenic in the hair and nails of these cases, and also in the hair of three non-fatal cases.

The estimated quantities of arsenic were as follows:—

Ahmed, fireman, s.s. "Pegu."

Arsenic in whole brain, ·0012 grain.
Arsenic in whole liver, taken as 60 oz., ·006 grain.
Arsenic in hair, ·02 grain per lb.
Arsenic in nails, ·04 grain per lb.

F. Biji, seaman, barque "Prince George."

Arsenic in whole liver, taken as 60 oz., ·0063 grain.
Arsenic in hair, ·014 grain per lb.

Negro, barque "Morgengry."

Arsenic in whole brain, ·0018 grain.
Arsenic in whole liver, taken as 60 oz., ·0052 grain.
Arsenic in hair, ·007 grain per lb.

Hasan, fireman, s.s. "Pegu."

Arsenic in hair, ·012 grain per lb.

J. Jansen, carpenter, barque "Argo."

Arsenic in hair, ·04 grain per lb.

J. Nielsen, barque "Morgengry."

Arsenic in hair, ·0028 grain per lb.

Minute quantities of arsenic were thus detected in the organs examined post mortem, and in the hair, of all the six cases in question. In the case of liver and brain in the three fatal cases the total amount of arsenic estimated to be present is in each instance so very small that no significance can safely be attached to the results in the absence of comparable analytical data from "control" cases. As regards the hair, it will be seen that two cases showed less than 1-100th grain of arsenic per pound of hair, while the remainder showed 1-80th, 1-70th, 1-50th, and 1-25th grain respectively. In general, these are larger proportions of arsenic than were found in the specimens of hair from "control" cases—persons taking no arsenic medicinally—which were examined in course of the Commission's hair inquiries (Appendix 32, Table A). On the other hand, the arsenic in the hair of these beri-beri cases is generally less than that which was found in the recently grown hair of persons taking small medicinal doses of arsenic (3 to 4) minims of liquor arsenicalis daily, Appendix 32, Table E).

In three out of the four cases showing more than 1-100th grain of arsenic to the pound of hair there is evidence that the patients ate dried fish containing some arsenic (1-80th grain to the pound in the specimens examined), and it seems probable that the arsenic detected in the hair of these cases was derived from the fish eaten or from some other food containing small quantities of arsenic. Two of the cases were firemen, and their occupation may have led to the inhalation of dust or fumes containing arsenic.

* The Commission's attention has been drawn by Professor Delepine and others to the presence of arsenic in potted shrimps due to the boracic acid used. *See* also Mr. Hammond Smith's Report (Appendix 24). Two samples of fish were consequently examined (though not exhaustively) for boron by Dr. McGowan. In each case the result was negative.

Appendix 31.

CONCLUSIONS AS TO INQUIRIES REGARDING SHIP-BORNE BERI-BERI AND ARSENIC.

Looking to the general effect of the evidence which the Commission has received as to chronic arsenical poisoning, it may be concluded that the above inquiries and chemical examinations, so far as they go, do not afford grounds for assuming that the beri-beri met with on ships arriving at home ports is essentially due to arsenic.

This may be said notwithstanding that minute amounts of arsenic have in some instances been found in specimens from beri-beri cases and in certain foods taken from the ships. Thus it seems possible that on Scandinavian sailing vessels dried fish containing as much arsenic as 1-30th grain per pound may be taken by sailors almost daily for months or years, and it is likely enough that arsenic taken in this way over long periods may here and there produce peripheral neuritis or other symptoms of poisoning in an individual who is specially susceptible to arsenic, particularly if his susceptibility is enhanced by deficiency of food. But quantities of arsenic of this order can hardly be related to the sudden appearance of the disease among several members of a crew at about the same time, in the manner which is illustrated by the history of a number of the vessels dealt with in these notes.

It should be added that several of these beri-beri cases are reported to have shown, in addition to affections of motor and sensory nerves, an amount of œdema, and an acuteness of cardiac symptoms, which have no parallel among the cases of arsenical beer poisoning in 1900. On the other hand it will be noted that the symptoms reported in one of the six cases from which specimens of tissue were obtained, Jon Jansen, barque "Argo," appear to have a closer resemblance to those of chronic arsenical poisoning than to those of "tropical" beri-beri. In this case the amount of arsenic found in the hair (1-25th grain per pound) suggests that the man must have recently taken a relatively considerable quantity of arsenic, either by way of the dried fish on the "Argo" or otherwise.

INQUIRIES AS TO ARSENIC AND BERI-BERI IN THE MALAY STATES.

A considerable number of inquiries into the causation of beri-beri have been made in the Federated Malay States, where serious prevalence of the disease is common, and copies of certain recent reports on beri-beri in these States have been sent by the Colonial Office to the Commission. It is evident that as yet the etiology of the disease in the Malay States (particularly as to the relation of beri-beri to particular articles of food or to particular toxins) is not understood. One or two of the reports in question discuss the possibility of arsenic being concerned with beri-beri, but they do not record any investigations for the detection of this or other mineral poison. Dr. A. J. McClosky has sent to the Commission a memorandum of the results of treating 38 beri-beri cases with arsenic at the District Hospital, Kuala Lumpur, a comparable series of 45 cases being treated at the same time without arsenic. The facts given show that arsenic was not beneficial; relatively fewer cases recovered when treated with arsenic. But, on the other hand, in certain cases protracted administration of considerable doses of liquor arsenicalis did not appear to retard recovery.

It will be remembered that in connection with the occurrence of beri-beri among communities in the tropics whose diet consists largely of rice, Dr. E. S. Reynolds (Q. 8381) drew attention to the statement that it is a common custom to put arsenic on rice fields to poison rats and keep them off the rice, and he referred to a letter from Dr. W. C. Brown regarding this practice in Acheen. Similar statements have been made by others. According to information supplied by Dr. Hughes in connection with the "Collingwood" cases, arsenic is also said to be used in Indian granaries to kill insects.

In 1902 Dr. H. E. Durham, who is inquiring, on behalf of the Beri-beri Committee of the London School of Tropical Medicine, into the etiology of beri-beri, kindly sent some rice samples to the Commission. Two of these samples consisted, in each case, of the total siftings through a fine sieve of a large bulk of rice (about 200lbs.) forming the main diet of prisoners at a gaol in Kuala Lumpur. One (B) weighing about 1-7th lb., was taken on September 24th, 1902, at a time when beri-beri was rife; the other (A), weighing about 1-10th lb., had been taken earlier, on July 28th, when the prevalence of the disease in the gaol had for a time diminished. Dr. Durham has since sent some further samples (C and D) of the siftings of a considerable bulk of rice (each representing a week's supply) consumed by sufferers from beri-beri in Pudu Gaol.

Dr. McGowan found (Table V. below) in rice siftings A 1-45th grain, in B 1-70th grain of arsenic per lb. of the dust. In C and D the proportions of arsenic per lb. of the siftings were 1-29th and 1-25th grain per lb. respectively. It is evident that the arsenic in these siftings could not have represented any appreciable quantity of arsenic in the large bulk of rice from which they were derived.

Dr. Durham also sent two pigtails from fatal cases of beri-beri, which have been examined for arsenic, with result shown in Table VI. It will be seen that a portion of one of the pigtails was specially extracted with ether and dilute hydrochloric acid in order to ascertain whether the arsenic present was due to extraneous matter. Nearly all the arsenic, however, was found to be contained in the substance of the clean hair.

July, 1903. G. S. B.

SECTION II.—DR. McGOWAN'S REPORTS ON EXAMINATION FOR ARSENIC OF VARIOUS SUBSTANCES IN CONNECTION WITH THE INQUIRY INTO BERI-BERI.

The results of these examinations are set out in the three following Tables, IV., V., and VI. Details of the methods summarised in Col. 6 of these tables appear in Appendix No. 22.

APPENDIX, No. 31—*continued.*

TABLE IV.

SHEWING RESULTS OF EXAMINATION FOR ARSENIC OF FOODS TAKEN FROM SHIPS IN CONNECTION WITH BERI-BERI.

1. Number of Sample.	2. Ship.	3. Description of Sample.	4. Date when Analysed.	5. Quantity taken for Analysis.	6. Method of Analysis.	7. Arsenic Mirror read. (Milligrammes).	8. Arsenic ($As_4 O_6$) Grains per lb. (Approximate fractions).	9. Parts per Million.	10. Notes as to Analysis.
1	"Fray"	Lime juice	28 Sept. 1901	20 c.c.	Direct Marshing	Merest trace	—	—	The whole 20 c.c. was Marshed, sulphites having been previously tested for.
2	"Fray"	Fish balls	3 Oct. 1901	51·2 grms.	Nitric and sulphuric acids	None	Arsenic-free	—	Seven-twentieths of extract Marshed, after toning with dilute sulphuric acid. A considerable quantity of sulphide came off in the "Marsh," but some subsequently added arsenic was recovered quantitatively from the same solution.
3	"Fray"	Stock fish from Rioar	19 Oct. 1901	50 grms.	Chlorate method	0·023	$\frac{1}{20}$	1·8	One-fourth of solution Marshed. *N.B.*—An estimation was made in the first instance by the nitric and sulphuric acids method, and this gave $\frac{1}{15}$th grain of arsenic per lb. But, owing to the large quantity of glue present, this method could not be trusted to give accurate results.
4	"Fray"	Potatoes (dried)	7 Dec. 1901	30 grms.	Chlorate method	0·024	$\frac{1}{20}$	1·6	One-half of solution Marshed. A special test, made afterwards, showed that practically all the arsenic had been extracted from the potatoes.
5	"Collingwood"	Preserved potatoes	12 Mar. 1902	30·0 grms.	Nitric and sulphuric acids	Mere trace	Mere trace	—	Two-fifths of extract Marshed. *N.B.*—An estimation was first made with 5·0 grms., which showed only a very faint indication of a mirror, and so it was thought well to make a second.

	"Collingwood"	Flour	18 Mar. 1902	10·0 grms.	Basic method, followed by direct Marshing.	None	Arsenic-free	—	Two-fifths of solution Marshed.
7	"Collingwood"	Dried fish	12 Dec. 1902	32·9 grms.	Chlorate method	0·015	$\frac{1}{500}$	0·5	Whole extract Marshed.
8	"Pegu"	Samsu (an alcoholic liquid of acid reaction).	15 Jan. 1903	50 c.c.	Evaporated with lime, the residue neutralized with hydrochloric acid to get rid of carbon dioxide; then Marshed.	Trace	Trace	—	Whole extract Marshed.
9	"Pegu"	Gin made at Schiedam in Holland.	23 Dec. 1902	40 c.c.	Alcohol evaporated off; then Marshed.	Mere trace	Arsenic-free	—	Whole extract Marshed.
10	"Pegu"	Rice	25 Mar. 1903	50 grms.	Extracted with known volume of aqueous hydrochloric acid at 50° C. for 15 minutes, decanted, and Marshed the solution.	Say 0·001	$\frac{1}{10}$	0·2	10 c.c., *i.e.*, the equivalent of 5 grms., were Marshed.
11	"Pegu"	Bombay duck	2 Jan. 1902	58·4 grms.	Chlorate method	0·022	$\frac{1}{50}$	1·9	One-fifth of extract Marshed.
12	"Cimbria"	Dried cod fish from Norway.	9 Dec. 1902	39·7 grms.	Chlorate method	0·016	$\frac{1}{150}$	0·8	Half of the extract Marshed.
13	"Argo"	Dried cod fish	29 Jan. 1903	50 grms.	Chlorate method	0·029	$\frac{1}{75}$	1·9	Half of the extract Marshed.
14*a*	"Argo"	(*a*) Tinned stock fish (balls in bouillon).	2 Feb. 1903	90 grms.	Chlorate method	0·0015	Mere trace, (arsenic-free).	0·02	Whole extract Marshed.
14*b*	"Argo"	(*b*) Juice from tinned stock fish.	7 Feb. 1903	88·6 grms.	Chlorate method	Mere trace	Arsenic-free	0·01	Whole extract Marshed.
15	"Argo"	Dried vegetables	19 Nov. 1902	10·0 grms.	Nitric and sulphuric acids	0·01	Trace	0·1	Whole extract Marshed.
16	"Argo"	Rice	16 Mar. 1903	50·0 grms.	Extracted with aqueous hydrochloric acid at 50° C. for 15 minutes, decanted, and—				
					(*a*) Marshed 10 c.c. directly.	Mere trace	Arsenic-free	—	The equivalent of 5 grms. Marshed.
					(*b*) Treated 68 c.c. by chlorate method.	0·0015	Trace	0·05	The equivalent of 34 grms. Marshed.
17	"Argo"	Drinking water	(*a*) 26 Apr. 1902	200 c.c.	(*a*) Evaporation, extraction of residue with hydrochloric acid, and Marshing of filtered solution.	None	(*a*) Arsenic-free	—	Whole extract Marshed.
			(*b*) 1 May 1902	200 c.c.	(*b*) As above, but Marshed the unfiltered extract.	Faintest trace of greyish mirror.	(*b*) Arsenic-free	—	Whole extract Marshed.

APPENDIX, No. 31—*continued.*

TABLE IV.—Shewing Results of Examination for Arsenic of Foods taken from Ships in connection with Beri-beri—*continued.*

1. Number of Sample.	2. Ship.	3. Description of Sample.	4. Date when Analysed.	5. Quantity taken for Analysis.	6. Method of Analysis.	7. Arsenic Mirror read. (Milligrammes).	8. Arsenic (As_2O_3) Grains per lb. (Approximate fractions).	9. Parts per Million.	10. Notes as to Analysis.
18	"Ben More"	Dried cod fish	17 Sept. 1902	30·0 grms.	Chlorate method	0·0165	$\frac{1}{240}$	0·6	Whole extract Marshed. Sample covered with small crystals.
19	"Ben More"	Tinned mutton	12 Dec. 1902	100 grms.	Chlorate method	0·0225	$\frac{1}{320}$	0·2	Whole extract Marshed.
20	"Ben More"	Lime juice	2 August 1902	10 c.c.	Direct Marshing	Faint dark ring	Trace.	—	—
21	"Ben More"	Rice	7 April 1903	50 grms.	Extracted with 100 c.c. of aqueous hydrochloric acid at 50° C. for 15 minutes; then Marshed 10 c.c.	None.	Arsenic-free.	—	The equivalent of 5 grms. Marshed.
22	"Charles Racine"	Dried fish	4 Dec. 1902	34·1 grms.	Chlorate method	0·011	$\frac{1}{43}$	0·3	Whole extract Marshed.
23	"Prince George"	Tinned fish from Norway.	7 Feb. 1903	100 grms.	Chlorate method	0·0025	Trace.	0·05	Half of extract Marshed.
24	"Prince George"	Juice from tinned fish sample.	7 Feb. 1903	91 grms.	Chlorate method (using very little chlorate).	0·015	$\frac{1}{130}$	0·17	Whole extract Marshed.
25	"Prince George"	Tinned Australian beef, packed in Queensland.	7 Feb. 1903	100 grms.	Chlorate method	0·0013	Mere trace, or arsenic-free.	—	Whole extract Marshed.
26	"Prince George"	Nestlé's milk	10 Feb. 1903	5·2 grms.	Nitric and sulphuric acids	None.	Arsenic-free.	—	Whole extract Marshed.
27	"Prince George"	Lime juice from the Seychelles.	20 Dec. 1902	20 c.c.	Direct Marshing (hydrochloric acid).	Merest trace.	Arsenic-free.	—	—
28	"Prince George"	Rice	18 Feb. 1903	5 grms.	Nitric and sulphuric acids	Trace.	Arsenic-free.	—	Whole extract Marshed. This sample was wrapped in a dirty newspaper. It was partly in the state of dust, and was weevilly.

29	'Somali'	Dried fish	29 Jan. 1903	30 grms.	Chlorate method	0·03	$\frac{1}{15}$	1·0	Whole extract Marshed.
30	"Somali"	Rice	29 March 1903	50 grms.	Extracted with 100 c.c. of aqueous hydrochloric acid at 50° C. for 15 minutes.	0·0025	$\frac{1}{80}$	0·5	The equivalent of 5 grms. of rice was Marshed.
31	"Sorata"	Tinned tomatoes (bought at Punta Arenas).	23 March 1903	339·5 grms., i.e. tomato plus juice.	Chlorate method	0·0015	Merest trace, if any.	—	Whole extract Marshed.
32	"Sorata"	Preserved cabbage from George Wyland's Preserving Works, Newcastle, N.S. Wales.	23 March 1903	167·8 grms. Cabbage plus some juice.	Chlorate method	0·0035	Mere trace.	0·02	Whole extract Marshed.
33	"Sorata"	Drinking water (taken in at Punta Arenas).	23 Dec. 1902	500 c.c.	Evaporated with a little lime to dryness in a porcelain basin, took up the residue with hydrochloric acid, warmed, and Marshed the whole.	Mere trace.	Arsenic-free.	—	There was a good deal of sediment from this evaporation, part of which was organic growth.
34	"Sorata"	Lime juice (bought at Punta Arenas).	20 Dec. 1902	20 c.c.	Direct Marshing (hydrochloric acid).	Mere trace.	Arsenic-free.	—	—
35	"Sorata"	Rice	25 March 1903	50 grms.	Extracted with aqueous hydrochloric acid at 50° C., as before.	Trace.	Trace (about $\frac{1}{1000}$).	—	The equivalent of 5 grms. of rice was Marshed.
36	"Morgengry"	Tinned fish (fish balls in bouillon).	2 Feb. 1903	100 grms. (fish balls alone).	Chlorate method	Mere trace.	Arsenic-free.	—	Whole extract Marshed.
37	"Morgengry"	Lime juice	22 Dec. 1902	20 c.c.	Direct Marshing (hydrochloric acid).	Mere trace.	Arsenic-free.	—	—
38	"Morgengry"	Drinking water	13 Jan. 1903	500 c.c.	Evaporated to small bulk, added a little hydrochloric acid; then warmed the whole to expel carbonic acid, and Marshed.	Trace, say 0·001. There was, in addition, a small white mirror, probably not arsenic.	Mere trace, or arsenic-free.	—	The whole Marshed.
39	"Morgengry"	Rice	25 March 1903	50 grms.	Extracted with 100 c.c. aqueous hydrochloric acid at 50° C., as before.	0·001	$\frac{1}{50}$	0·2	The equivalent of 5 grms. was Marshed.

APPENDIX, No. 31—*continued.*

TABLE IV.—Showing Results of Examination for Arsenic of Food taken from Ships in connection with Beri-beri—*continued.*

1. Number of Sample.	2. Ship.	3. Description of Sample.	4. Date when Analysed.	5. Quantity taken for Analysis.	6. Method of Analysis.	7. Arsenic Mirror read. (Milligrammes).	8. Arsenic ($As_4 O_6$). Grains per lb. (Approximate fractions.)	9. Parts per Million.	10. Notes as to Analysis.
40	"Handeljust"	Drinking water	15 Jan. 1903	500 c.c.	Evaporated to small bulk, warmed with a little hydrochloric acid, and Marshed.	Merest trace	Arsenic-free	—	—
41	"Handeljust"	Sugar (white crystals)	29 Jan. 1903	10 grms.	Direct Marshing (hydrochloric acid).	None.	Arsenic-free	—	—
42a	"H. C. Richards"	Fish balls	27 Feb. 1903	100 grms.	Chlorate method	0·0018	Mere trace	0·02	Whole extract Marshed.
42b	"H. C. Richards"	Juice from above fish balls.	27 Feb. 1903	48·6 grms., *i.e.* nearly all the juice.	Chlorate method	Trace.	Mere trace	—	Whole extract Marshed.
43	"H. C. Richards"	Rice	20 Mar. 1903	50 grms.	Extracted with 100 c.c. aqueous hydrochloric acid at 50° C., as before.	Merest trace	Arsenic-free	—	The equivalent of 5 grms. Marshed.
44	"Victor"	Dried fish	17 Sep. 1902	21·4 grms.	Chlorate method	0·018	$\frac{1}{10}$	0·9	Whole extract Marshed.
45	"Victor"	Rice	7 Apr. 1903	50 grms.	Extracted with 100 c.c. aqueous hydrochloric acid at 50° C., as before.	None. A slight trace of a whitish mirror.	Arsenic-free	—	The equivalent of 5 grms. Marshed.

NOTE.—In column 8, the term "trace" in each instance denotes a proportion of arsenic below $\frac{1}{1000}$th grain per lb. The term "arsenic-free" denotes either that no arsenic was detected, or that if arsenic appeared to be present, it was in such small proportion, relative to the weight of the substance examined, as to hardly admit of the use of the term "trace."

TABLE V.

SHEWING RESULTS OF EXAMINATION FOR ARSENIC OF THE SIFTINGS OF RICE (RICE DUST), CONSUMED BY SUFFERERS FROM BERI-BERI IN GAOLS IN KUALA LAMPUR, SENT BY DR. H. E. DURHAM.

1. Number of Sample.	2. Description of Sample.	3. Date when Analysed.	4. Quantity taken for Analysis.	5. Method of Analysis.	6. Arsenic mirror read. (Milligrames).	7. Arsenic ($As_4 O_6$). Grains per lb.	8. Parts per million in dust.	9. Notes as to Analysis.
46	A.—Rice Siftings: Dust sifted through iron wire gauze from rice in use at gaol during lull in beri-beri. Packet sent represented about 200 lbs. of rice. July 28, 1902.	4 Nov. 1902	5·0 grms.	Nitric and sulphuric acids	0·016	$\frac{1}{4}$	3·2	The whole extract Marshed. (Total dust = 46·9 grammes). Calculating this result on the 200 lbs. of rice, we get the merest trace of arsenic.
47	B.—Rice Siftings: Similar to "A," but taken at the height of an outburst of beri-beri. September 24, 1902.	6 Nov. 1902	5·0 grms.	Nitric and sulphuric acids	0·010	$\frac{1}{8}$	2·0	The whole extract Marshed. (Total dust = 65·3 grammes.) Here, again, this gives the merest trace of arsenic in the bulk of the rice.
48	C.—Rice Siftings: Rice siftings from Pudoh Gaol. Sample of week's supply for week ending January 8, 1903.	May 1903	5·0 grms.	*Nitric acid.*—The nitric acid residue was extracted with ammonia, to get rid of dirty sand, the amount of which was considerable. The filtrate was then evaporated with lime water and the residue ignited. It was then dissolved in hydrochloric acid for Marshing.	·010	$\frac{1}{5}$	5·0	Two-fifths of extract Marshed. As stated, this contained at least 5% of dirty sand. Weight of rice corresponding to siftings sent not stated.
49	D.—Rice Siftings: Similar sample to "C," but representing the week's supply for week ending January 19, 1903.	8 May 1903	5·0 grms.	*Nitric acid, etc.*—As with sample "C."	0·012	$\frac{1}{3}$	5·8	Two-fifths of extract Marshed. This sample also contained much dirty sand. Weight of rice corresponding to siftings sent not stated.

APPENDIX, No. 31—*continued.*

TABLE VI.

SHOWING RESULTS OF EXAMINATION FOR ARSENIC OF POST-MORTEM AND HAIR SPECIMENS FROM BERI-BERI PATIENTS.

1. Number of Sample.	2. Description of Sample.	3. Date when Analysed.	4. Quantity taken for Analysis.	5. Method of Analysis.	6. Arsenic Mirror read. (Milligrammes).	7. Arsenic ($As_4 O_6$). Grains per lb.	8. Parts per Million.	9. Calculated quantity of arsenic in whole liver or brain.	10. Notes as to Analysis.
	A.—Specimens obtained post-mortem from fatal case. Ahmed S.S. "Pegu." Received December 23rd, 1901, and kept in ice.								
51	Brain	28 Jan. 1902	149·2 grms., chiefly cerebellum and grey matter. (Whole brain = 1068·2 grms.)	Chlorate method	0·0053 After deducting blank done in case of liver.	$\frac{1}{1000}$	0·07	$\frac{1}{5\frac{1}{2}0}$	Half the extract Marshed.
52	Liver	13 Jan. 1902	162·2 grms. (This constituted about half the liver in Jar I.)	Chlorate method	0·0290 After deducting blank of 0·0010.	$\frac{1}{570}$	0·26	—	$\frac{1}{11}$ of extract Marshed. *Note.*—Another portion of the extract, 10 c.c., was Marshed also. This gave a mirror equal to 0·0145, after deducting 0·0005 for blank. The two "Marsh's" thus agree very closely.
53	Liquor from Jar.—(The jar contained liver, hair, nails, kidney, spleen, lung, heart, skin and muscle. The total liquor weighed 511 grms.)	7 Feb. 1902	162·5 grms.	Chlorate method	0·0165 After deducting two-thirds of liver blank.	—	0·32	$\frac{1}{1560}$ in whole liquor.	Whole extract Marshed.
54	Hair.—This hair had got steeped in the liquor. It weighed 6·1 grms. wet. An experiment made with another portion of hair showed that it would have weighed about 2·06 grms. if dry.	13 Jan. 1902	6·1 grms. wet hair = 2·06 grms. dry hair.	Chlorate method	0·0057 After deducting blank of 0·0023. This blank was not so satisfactory as that of the liver.	$\frac{1}{170}$ On the dry hair.	2·8	—	Whole extract Marshed.
55	Nails.—These were wet and weighed 2·6 grms.	13 Jan. 1902	2·6 grms. wet nails	Chlorate method	0·0093 After deducting blank of 0·0007.	$\frac{1}{74}$ On the wet nails.	5·4	—	$\frac{1}{14}$ of extract Marshed.

	B.—Specimens obtained post-mortem from Franz Biji, Norwegian, aged 22. Barque "Prince George." Received April 22nd, 1902:								
56	Liver - - - - - -	2 May 1902 -	107·7 grms.	Chlorate method -	0·017 Mean of four readings. No blank done; not considered necessary.	$\frac{1}{6\cdot5}$	0·24		Two-thirds of extract Marshed. *Note.*—The first "Marsh" done was with 10 c.c., *i.e.*, with one-third of the extract. This gave a mirror equal to 0·0095, which agrees well with the above.
57	Hair.—This weighed 4·2 grms.	27 Feb. 1903 -	4·2 grms.	Chlorate method -	0·009	$\frac{1}{7\cdot5}$	2·1	—	Whole extract Marshed. *Note.*—There was a distinct brown mirror on the wrong side of the flame, and also a ring on the right side, but too near the flame to be read with the true arsenical mirror. (? Antimony).
58	Nails.—These weighed only 0·5 grm.	6 May 1902 -	0·5 grm.	Nitric and sulphuric acids.	Only the faintest mirror -	—	—	—	Whole extract Marshed. *Note.*—The proportion of arsenic in the nails may possibly have been appreciable, but the weight of the sample was much too small for an accurate estimation.
	C.—Specimens obtained post-mortem from negro, aged 19. Barque "Morgengry." Received June 6th, 1902:								
59	Liver - - - - - -	10 June 1902 -	113·1 grms.	Chlorate method -	0·015	$\frac{1}{7\cdot5}$	0·2		Two-thirds of extract Marshed.
60	Brain - - - - - -	10 June 1902 -	126·5 grms.	Chlorate method -	0·009 Not a very good reading.	$\frac{1}{1250}$	0·11	—	Two-thirds of extract Marshed.
61	Hair - - - - -	17 Sept. 1902 -	12·5 grms.	Nitric and sulphuric acids.	0·014	$\frac{1}{11\cdot5}$	1·1	—	Whole extract Marshed.
62	Nails - - - - - -	17 Sept. 1902 -	2·25 grms.	Nitric and sulphuric acids.	Mere trace - - - -	—	—	—	Whole extract Marshed. *Note.*—This was another very small sample. It may quite possibly have contained an appreciable proportionate quantity of arsenic.

APPENDIX, No. 31—*continued.*

TABLE VI.—Showing Results of Examination for Arsenic of Post-mortem and Hair Specimens from Beri-beri patients—*continued.*

1. Number of Sample.	2. Description of Sample.	3. Date when Analysed.	4. Quantity taken for Analysis.	5. Method of Analysis.	6. Arsenic Mirror read. (Milligrammes).	7. Arsenic ($As_4 O_6$). Grains per lb.	8. Parts per Million.	9. Notes to Analysis.
	D.—Hair Specimens from non-fatal cases of Beri-beri:							
63	Hasan, S.S. "Pegu," aged 26.	2 March 1903	1·9 grms.	Chlorate method	0·0033	$\frac{1}{300}$	1·7	Whole extract Marshed.
64	Jon Jansen, Barque "Argo," aged 47.	17 March 1903	1·5 grms.	Chlorate method	0·0085	$\frac{1}{118}$	·7	Whole extract Marshed. *Note.*—Brown mirror on wrong side of flame, and also on the right side, but this latter too close to the flame to be read as arsenic.
65	Jacob Nielson, Barque "Morgenry," aged 18.	18 Feb. 1903	5·0 grms.	Nitric and sulphuric acids.	0·002	$\frac{1}{213}$	0·4	Whole extract Marshed.
	E.—Two pigtails sent by Dr. Durham:							
66(*a*)	No. 45A. Root portion, about 9 inches long.	7 March 1903	8·3 grms. *i.e.* whole portion.	Chlorate method	0·019 Not a very satisfactory reading.	$\frac{1}{53}$	9·2	One-quarter of extract Marshed. This pigtail was very dirty, and it had a strong acrid smell like butyric acid.
66(*b*)	No. 45B. Remainder, about 18 inches long.	7 March 1903	8·2 grms. *i.e.* whole portion.	Chlorate method	0·018 Not a very satisfactory reading.	$\frac{1}{58}$	8·8	One-quarter of extract Marshed.
67(*a*)	No. 44A. Root portion, 4 inches long.	2 March 1903	9·7 grms. *i.e.* whole portion.	Chlorate method	0·015	$\frac{1}{63}$	6·2	One quarter of extract Marshed.
67(*b*)	No. 44A. Third portion, about 4 inches long. *Note.*—The second portion, about 18 inches long, was tested later.*	2 March 1903	5·0 grms. *i.e.* whole portion.	Chlorate method	0·012	$\frac{1}{75}$	4·8	One-half of extract Marshed.
67(*c*)	No. 44A. Remainder (*i.e.* loose end), about 14 inches long.	2 March 1903	10·1 grms. *i.e.* whole portion.	Chlorate method	0·025	$\frac{1}{45}$	5·0	One-half of extract Marshed.

* In order to see how far the arsenic might be contained in dirty matter adhering to the hair, the second portion of pigtail No. 44a was thoroughly extracted, (1) by ether (five or six extractions in the cold), and (2) with excess of dilute hydrochloric acid (containing 1 per cent. HCl.) for half an hour at 50° C. The arsenic extracted by the ether represented $\frac{1}{75}$th grain per lb. of hair (1·74 parts per million); no further arsenic was extracted by the hydrochloric acid; the remaining hair, which was clean and tough, contained $\frac{1}{77}$rd grain of arsenic per lb. (6·12 parts per million). The second portion of No. 44a thus contained altogether $\frac{1}{75}$th grain per lb. (7·86 parts per million), 78 per cent. of the arsenic remaining in the hair after the above two extractions.

GEORGE MCGOWAN.

APPENDIX 32.

ARSENIC IN HAIR.

REPORT ON INVESTIGATIONS MADE FOR THE COMMISSION AS TO THE ELIMINATION OF ARSENIC BY THE HAIR.

The reports on this subject are arranged as follows:—

I.—General account of inquiry and tables giving an analysis of the principal results obtained.

II.—Report by Mr. R. F. Wood Smith on the methods adopted by him in testing specimens of hair.

III.—Tabular statements showing the condition as to arsenic of the persons whose hair was examined, and the results of examination, namely:—

TABLE A.—Males who had taken no arsenic medicinally at the date of collection of the specimen of hair.

TABLE B.—Females who had taken no arsenic medicinally at the date of collection of the specimen of hair.

TABLE C.—Males who at the date of collection of the hair specimen had taken, or who had recently discontinued taking, arsenic in known quantities medicinally.

TABLE D.—Females who at the date of collection of the hair specimen had taken, or who had recently discontinued taking, arsenic in known quantities medicinally.

TABLE E.—Later series of male cases who at the date of collection of the hair specimen had lately been taking arsenic medicinally in very small doses.

TABLE F.—Cases of alcoholic neuritis from certain London hospitals and infirmaries.

I.—GENERAL ACCOUNT OF THE INQUIRY AND TABLES GIVING AN ANALYSIS OF THE PRINCIPAL RESULTS.

Evidence given to the Commission by Dr. Dixon Mann (Q. 3741-8) as to finding arsenic in the hair of patients suffering from arsenical beer poisoning at Manchester, and also information supplied by Messrs. Dearden and Knecht of Manchester, who had reported ("Lancet," March 23rd, 1901) on the examination of hair of one or two other Manchester cases* suggested that the fact of elimination of arsenic by the hair might prove important in instances (such as supposed alcoholic neuritis) where it was desirable to ascertain whether a given patient had lately been taking arsenic, either as a contamination of beer or food, or medicinally.

The Commission desired that some experimental evidence on this subject should be obtained with a view to throwing light on the following points:—

Whether persons known not to have taken arsenic medicinally, and not, so far as known, specially liable to receive arsenic in other ways, ordinarily show any noteworthy quantity of arsenic in their hair.

Whether persons whose hair is free from (or contains no more than a minute trace of) arsenic come to show noteworthy quantities of arsenic in their hair as a consequence of taking arsenic medicinally; how soon after arsenic has begun to be taken will evidence of arsenic appear in the recently grown hair; and whether arsenic can be detected in the hair of persons who have discontinued taking arsenic medicinally for a considerable number of weeks.

In the case of long female hair, whether any differences which may be observed between the quantity of arsenic near the roots and towards the tips respectively, correspond to known facts as to arsenic taking.

The Commission engaged the services of Mr. R. F. Wood Smith to analyse hair samples for arsenic. In order to obtain specimens of hair for examination, advantage was taken in the first instance of an offer kindly made by Dr. A. E. Garrod, who at that time was Medical Registrar of St. Bartholomew's Hospital, and who is also one of the physicians at the Hospital for Sick Children, Great Ormond Street. At the latter hospital children are frequently admitted suffering from chorea, and there treated with arsenic, and these cases seemed likely to be suitable for the purpose required.

Preliminary Specimens.

Between April and June, 1902, Dr. Garrod obtained some fifteen samples, both before and after treatment, from children at Great Ormond Street who were taking arsenic medicinally, and these samples were tested in Mr. Wood Smith's laboratory. Considerable difficulty arose, however, in interpreting the results obtained. In some cases no arsenic was detected in the hair before treatment, and a notable quantity (*e.g.*, 1-50th to 1-80th grain per lb.) was apparent after arsenic had been taken for three or four weeks. But in other cases amounts such as 1-55th and 1-30th grain of arsenic per lb. were found in the hair sample before arsenic had begun to be given at the hospital. It seemed possible that these latter cases had in fact been taking arsenic before they were admitted to hospital, particularly as

* *See* also Gautier, Comtes Rendus, 1899 and 1900.

Appendix 32.

this drug is often given in cases of chorea, but no definite information on the point could be obtained. There was also another reason why these Great Ormond Street cases proved to be less satisfactory than was anticipated, namely, the fact that the patients were seldom sufficiently long in the hospital, and consequently it was often impossible to obtain specimens of hair which had grown solely during the period of arsenic taking.

In these circumstances it was considered that future specimens had best be obtained from general hospitals in London, and from those cases only in which there was a probability that the patient would remain in hospital for a considerable number of weeks, and would be taking arsenic throughout his or her stay there.

Control Specimens.

The suggestion obtained from the Great Ormond Street cases that possibly hair of persons not known to have been taking arsenic might nevertheless show such amounts as 1-30th grain per lb., made it necessary however to examine a preliminary series of "control" samples before proceeding further. Twelve such hair samples were obtained, some from private sources and some from hospitals. It was arranged with Mr. Wood Smith that if any of these samples showed a noteworthy amount of arsenic, then experiments were to be tried with washing to see if the arsenic present was in the substance of the hair or was due to dust, etc., on the outside.

All the samples of this preliminary series yielded, however, a negative result, or else a proportion of arsenic below 1-250th grain per lb., with one exception (a man whose hair showed 1-150th grain per lb.).

A series of samples of male hair collected in August by a London hairdresser (13 in all) yielded similar results. Seven showed no arsenic, two contained less than 1-250th grain per lb., and four contained amounts between 1-250th and 1-150th.

These results did not suggest that any considerable amount of arsenic was likely to be contained in hair as the result of contamination by dust, and accordingly the question of washing was not pursued.*

Subsequently additional "controls" have been examined in connection with hospital and infirmary cases. Altogether the total number of control samples, male and female (exclusive of the hairdresser's samples), examined for arsenic was 41. These are shown in Tables A and B. Of these, 17 showed "no arsenic" by Mr. Wood Smith's test (which allows an approximate assessment of quantity down to 1-400th grain per lb.), 16 showed a "trace" of arsenic (in each instance below 1-250th grain per lb.); of the remainder, one showed 1-250th, one 1-200th, three 1-150th, and one 1-100th grain of arsenic per lb. In one sample (Table C, No. 77), 1-50th grain arsenic per lb. was estimated, but there is some element of doubt in this case, as it was afterwards found that the patient, an epileptic, had been taking large doses of Easton's Syrup (phosphates of iron, quinine, and strychnine), three drachms daily, for two months before the control sample was taken. In one other (Table E, No. 93) the control sample showed 1-25th grain of arsenic per lb. The source of the arsenic in this case could not be ascertained. No hair dye or other application to the hair appeared to have been used.

Specimens from Arsenic-takers.

The next set of specimens from persons taking arsenic was obtained from London hospitals through the kindness of their medical registrars, especially Dr. Garrod at St. Bartholomew's and Dr. French at Guy's. Mr. Hammond Smith also obtained some samples from Middlesex Hospital, and Dr. Redfern, of Croydon, supplied some hair from private sources. It was found difficult, however, to obtain sufficient samples of the kind required; in-patients taking arsenic were surprisingly few; there was often uncertainty as to medicine taken before admission; frequently the patient left the hospital without having taken arsenic sufficiently long for a satisfactory sample to be obtained. Moreover, although forms for particulars were drawn up for the convenience of the collectors, and the nature of the samples required was stated, there was necessarily an element of uncertainty due to the fact that the specimens might be collected in different ways by different observers.

These difficulties were ultimately met by resorting to certain of the London Poor Law infirmaries, where it is usual for patients to be under treatment in the institution for a considerable time. Mr. Hammond Smith undertook to visit the medical superintendents of the infirmaries selected, and to personally take, or supervise the collection of, the specimens required. Subjoined are notes which he has furnished on the result of these visits:—

"After visiting these infirmaries I found that there would be no difficulty in securing by the co-operation of the medical staff an abundance of samples of the kind desired. A considerable number of patients had been taking arsenic for some time at the date of my visit, and from these I obtained samples of hair† I endeavoured to obtain in each instance at least a 2-gramme weight of sample. In a few instances the hair was so scanty that less than 2 grammes was obtained.

"Other cases were considered by the medical superintendent to be likely to benefit by small doses of arsenic. At Paddington, Marylebone, Wandsworth and Clapham, Tooting, and St. George's Infirmaries, the medical superintendents were good enough to inform me of such cases, and to give me facilities for obtaining samples of hair before the arsenical treatment was commenced. In these cases I was able to obtain a considerable number of 'control' samples, and I selected those which had been in the infirmary for many weeks, and were known to have taken no arsenic medicinally during that period.

"In obtaining these 'control' samples, in the case of males, the hair of the back of the head was cut as near as possible to the roots with scissors, or preferably clippers. In the case of females, a lock was made up by cuttings from various parts of the head, and the root ends tied together. Owing to the objection which the women had to parting with their hair this was not always an easy task.

"I then procured samples from the same cases after the arsenic had been taken, in known doses, for various periods; wherever possible, after an interval as long as two months. In the case of men the hair was again cut at the spot where the control sample had been taken. The length of growth during the two months, of course, varied in different individuals; the usual length was about 1½ inches—exceptionally it was up to 2 inches. In the case of the women, the sample was taken exactly as in the control, and the instruction given to the analyst was to test only about 2 inches at the root end of the sample. It is evident that in the case of the women this 2 inches of sample would not represent so exactly hair which had grown during the period of arsenic taking, as in the case of the men. The 2 inches was merely guess work and might or might not have represented the length which had grown in two months. Moreover, in women the rate of growth of old hairs that are already long is probably much slower than that of young short hairs. A further uncertainty in the female cases was due to the fact that the analyst requires somewhere about 2 grammes, and, where the lock obtained was thin he could not get the weight desired in 2 inches taken at the root end.

"The samples obtained from women who at the date of my visit had already been taking arsenic for some weeks were obtained in a similar way. In these cases the instructions to the analyst usually depended on the time the arsenic had been taken, and also on the abundance of the hair: Sometimes, for instance, he was asked to examine the whole

* Prolonged washing in a stream of water through a sieve with a fine mesh was tried in two instances. One hairdresser's sample (1-150th grain per lb.) still showed 1-150th grain per lb. after washing; in another sample the arsenic was reduced by the washing from 1-200th to 1-250th grain per lb.

† Such samples constitute the bulk of cases recorded in Tables C. and D.

length of the hair; sometimes to take so many inches at the root end, and test them separately from the remaining portion.*

"From these infirmaries I obtained a considerably larger number of samples and controls than could be examined by the analyst. In selecting, in consultation with Dr. Buchanan, which samples should be analysed, regard was had (1) to the question whether the samples (control and sample after taking arsenic) were sufficiently abundant; (2) to the dose taken; and (3) to the form in which the arsenic had been administered. It was thought best to exclude all cases in which the arsenic had been given in pill or as 'Donovan's solution'; and to select only those taking liquor arsenicalis—or, in one or two cases, liquor sodii arsenatis, which contains the same quantity of arsenic as liquor arsenicalis. As the effect of small quantities of arsenic on the hair was particularly important for the inquiry, we did not select any cases that had taken more than 9 minims of liquor arsenicalis (about 1-12th grain—or 5·4 milligrams—arsenious oxide) per day. Many of the cases had taken just 9 minims a day, usually in 3 minim doses three times a day.

"I did not at first obtain any samples where the daily dose had been so very small as 1-30th grain—or 2·16 milligram—per diem, but subsequently on March 1st, 1903, the medical superintendent of one infirmary was good enough to arrange to administer very small doses (1 minim three times a day, and 1½ minims three times a day before meals) to cases under his observation where arsenic would probably be beneficial, after giving me an opportunity of taking control samples. After an interval of about two months, the hair in some of these cases was collected for analysis.

"I may note that, as it happened, hardly any of the samples taken were of light coloured hair. Most of them were dark brown or black, and a few were white or grey."

The facts regarding the various specimens obtained from persons taking arsenic medicinally are shown in Tables C (males) and D (females), from which, for reasons given above, the children from Great Ormond Street have been excluded.

The degree of correspondence which was found to exist betweeen the proportions of arsenic in the hair examined and the known conditions as regards the medicinal administration of arsenic will be gathered from the tables referred to, and also from the following summary tables:—

* The instructions given are noted in each instance in the last column of Table D.

APPENDIX, No. 32—*continued.*

ARSENIC IN HAIR:—SUMMARY TABLES.

I.—Males over 15. Analysis of Cases detailed in Tables A. and C. Numbers signify the Reference Numbers of the Cases in those Tables.

Condition as to Arsenic at Date of Collection of Sample.	Total Cases.	Amount of Arsenic Detected in Grains of Arsenious Oxide per Pound of Hair. (*Italic* figures = parts per million.)								
		Free.	Trace (below $\frac{1}{250}$ grain per lb.).	$\frac{1}{250}$ — $\frac{1}{100}$ (*0·57*)	$\frac{1}{100}$ — $\frac{1}{50}$ (*1·4*)	$\frac{1}{50}$ — $\frac{1}{25}$ (*2·8*)	$\frac{1}{25}$ — $\frac{1}{15}$ (*5·7*)	$\frac{1}{15}$ — $\frac{1}{8}$ (*9·5*)	$\frac{1}{8}$ — $\frac{1}{4}$ (*18*)	$\frac{1}{4}$ or more. (*36*)
No arsenic taken—										
See Table A.	28	7, 26, 76*a*, 82*a*, 83*a*, 94*a*, 96*a*, 100*a*, 102*a*, 103*a*, 108*a*.	4, 74*a*, 75*a*, 79*a*, 80*a*, 81*a*, 95*a*, 101*a*, 106*a*, 107*a*.	3, R.S., 73*a*, 78*a*	97*a*	77*a*	93*a*	—	—	—
No evidence that arsenic taken—										
See Table A., Hairdressers' Samples	13	7 samples	2 samples	4 samples	—	—	—	—	—	—
Arsenic taken for *—										
5 weeks or less: 9 minims or less than 9 minims liquor arsenicalis daily.	4	—	—	32, 33	—	41	—	38	—	—
5 weeks or less: Over 9 minims liquor arsenicalis daily.	4	—	25	—	21	—	30	62	—	—
More than 5 weeks: 9 minims or less than 9 minims liquor arsenicalis daily.	18	—	—	—	45	75*b*	77*b*, 80*b*	37, 39, 73*b*, 78*b*, 83*b*	74*b*, 76*b*, 79*b*, 81*b*, 82*b*, 6	34, 67, 68
More than 5 weeks: Over 9 minims liquor arsenicalis daily.	6	—	—	—	52	24	—	13, 105	8	47, 59
Arsenic taken for some time and lately discontinued—										
From 2 to 5 weeks before collection of sample: 9 minims or less than 9 minims liquor arsenicalis daily.	1	—	—	—	—	—	—	35	—	—
From 2 to 5 weeks before collection of sample: Over 9 minims liquor arsenicalis daily.	1	—	—	—	—	—	—	57	—	—
Longer than 5 weeks before collection of sample: 9 minims or less than 9 minims liquor arsenicalis daily.	1	—	—	—	—	36	—	—	—	—
Longer than 5 weeks before collection of sample: Over 9 minims liquor arsenicalis daily.	—	—	—	—	—	—	—	—	—	—

Cases where the arsenic had been discontinued for not more than 14 days before the collection of the sample are included under this head.

II.—Females over 15. Analysis of Cases in Tables B. and D. The Numbers signify the Reference Numbers of Cases in those Tables.

Condition as to Arsenic at Date of Collection of Sample.	Total Cases.	Amount of Arsenic Detected in Grains of Arsenious Oxide per Pound of Hair. (*Italic* figures = parts per million.)								
		Free.	Trace (below $\frac{1}{250}$ grain per lb.)	$\frac{1}{250}$ – $\frac{1}{100}$. (*0·57*)	$\frac{1}{100}$ – $\frac{1}{50}$. (*1·4*)	$\frac{1}{50}$ – $\frac{1}{25}$. (*2·8*)	$\frac{1}{25}$ – $\frac{1}{15}$. (*5·7*)	$\frac{1}{15}$ – $\frac{1}{8}$. (*9·5*)	$\frac{1}{8}$ – $\frac{1}{4}$. (*18*)	$\frac{1}{4}$ or more. (*36*)
No arsenic taken (*See* Table B.)	12	5, 69*a*, 86*a*, 87*a*, 88*a*	1, W.F., M.S., 71*a*, 72*a*, 84*a*, 85*a*	—	—	—	—	—	—	—
Arsenic taken * in larger or smaller † doses :—										
For 5 weeks or less — Whole length	2	29	31	—	—	—	—	—	—	—
For 5 weeks or less — Roots	7	—	61	27, 28	—	65, 72*b*	85*b*	—	56	—
For 5 weeks or less — Tips	5	—	27, 28, 61, 65	—	56	—	—	—	—	—
For more than 5 weeks — Whole length	5	—	—	—	(Middle) 40	—	—	—	58, 60, 69*b*	66
For more than 5 weeks — Roots	13	—	16, 71*b*, 87*b*	—	17	48, 49, 50	84*b*, 88*b*	40, 51, 86*b*	—	64
For more than 5 weeks — Tips	5	16, 40, 48	50	17	—	—	—	—	—	—
Arsenic lately discontinued :—										
From 2 to 5 weeks before collection of sample — Whole length	—	—	—	—	—	—	—	—	—	—
From 2 to 5 weeks before collection of sample — Roots	—	—	—	—	—	—	—	—	—	—
From 2 to 5 weeks before collection of sample — Tips	—	—	—	—	—	—	—	—	—	—
Longer than 5 weeks before collection of sample — Whole length	1	—	—	—	—	—	—	46	—	—
Longer than 5 weeks before collection of sample — Roots	1	—	—	—	—	—	—	63	—	—
Longer than 5 weeks before collection of sample — Tips	1	—	—	—	—	63	—	—	—	—

* Cases in which arsenic has been discontinued for no longer than 14 days before the sample was collected are included under this head.

† In order not to overcrowd this table with details, no classification as regards the dosage of arsenic is here made. The details as to dosage can be obtained from the General Table D.

Appendix 32.

In the above Summary Tables cases which at the date of collection of the hair specimen had been taking arsenic for less than five weeks are shown separately from the rest of the cases taking arsenic. In nearly all these cases no "control" samples were available, and, owing to the short time during which arsenic had been given, the extent to which the samples examined contained hair which had grown during the period of arsenic taking was necessarily uncertain.

Looked at as a whole, the facts summarised in the above tables are striking. They leave no room for doubt that the hair grown by persons, both male and female, whilst they are taking solutions of arsenious oxide nearly always contains arsenic in notable amount. The proportions of arsenic in such hair are usually of an order quite different from the small quantities occasionally met with in the hair of "controls" believed to be taking no arsenic.

The distinction is evident even when the dose of arsenic is small. Table E shows separately the results of examination of the hair in the special series of male cases referred to in Mr. Hammond Smith's notes, where minute doses of arsenic (1 or 1½ minims of liquor arsenicalis three times a day, or 1-33rd to 1-22nd grain of arsenic daily) were given for about two months. Excluding case 93 (the exceptional "control" alluded to above), there were "control" samples, taken before arsenic was given, from 11 cases as follows:—

Free from arsenic - - - - -	6
Trace of arsenic below 1-250th grain per pound of hair - - - - -	4
1-100th grain of arsenic per pound of hair -	1

At the end of two months samples from the same 11 cases showed amounts of arsenic per pound of hair as follows:—

Trace, below 1-250th - - - - -	1
1-100th - - - - - - -	1
Above 1-100th and below 1-25th - - -	5
1-25th and over - - - - - -	4

Here it may be added that in one or two instances in course of the inquiry an exceptional chemical result led to information being obtained as to means, previously unknown, by which the patient had been taking arsenic. For example, in case 103a (Table E.) the sample of hair taken in March 3rd, before liquor arsenicalis was given, was free from arsenic; the sample 103b, cut to the roots with clippers on May 6th, after 4½ minims of liquor arsenicalis had been taken daily for nine weeks, showed 1-50th grain per lb. On June 30th sample 103c was collected, in the belief that no liquor arsenicalis had been taken since May 6th. Notwithstanding that this man's hair had been cut in the ordinary course once between May 6th and June 30th, this sample (103c) showed 1-40th grain per lb. Further inquiry showed that on May 25th he had resumed taking liquor arsenicalis in the same doses as before, and had continued this medicine up to June 30th.

The difficulty which arises in obtaining satisfactory samples representing women's hair which has grown during the period of arsenic taking has already been mentioned. No doubt for this reason there was in the case of females less correspondence between the hair of patients under identical conditions as to dosage and period of arsenic taking than in the case of males.

Samples of hair were taken in a few instances where the patient had ceased to take arsenic for a considerable number of weeks. In most of these samples noteworthy amounts of arsenic were present. It seems possible that elimination of arsenic by the hair may continue for some while after arsenic has ceased to be taken, but the data available are not sufficient to allow any precise conclusion on this matter to be drawn.

Hair of Brewers' Draymen.

Mr. Wood Smith this year obtained samples of hair from three brewers' draymen who habitually take large quantities of beer supplied by a brewery at which much attention has been given to the exclusion of arsenic from beer. Two of these samples were free from arsenic; one showed a trace of arsenic, below 1-250th grain per pound of hair.

Hair from Alcoholic Neuritis cases.

In some instances, shown in Table F, specimens of hair were obtained from cases of alcoholic neuritis in London hospitals and infirmaries, together with particulars of the kind of alcoholic drink habitually taken. None of these cases showed pigmentation or other symptoms pointing to arsenic as the cause of the neuritis, and none had been taking arsenic as medicine.

Now that the results obtained in persons taking small doses of arsenic medicinally are available, it may be concluded that examination of hair is capable of affording a valuable indication in cases of "alcoholic neuritis," where it is important to know whether or not arsenic has been concerned in producing the illness. In the cases shown in Table F, however, the samples obtained were seldom of a kind which allowed a satisfactory positive or negative conclusion with regard to arsenic to be drawn from the results of examination of the hair. Two cases only were men, and at the date on which the hair specimen was taken each had been in hospital, and had left off alcohol for several weeks, and his hair had been cut once or oftener since admission. In some of the female cases the hair was collected and examined at an early stage of the inquiry before the importance of dividing the hair specimen into sections was fully realised; in several others the sample sent was so small that examination in sections was impracticable. It is evident that a result of, say, 1-100th grain of arsenic per lb. in a thin lock of hair 12in. long is not conclusive as a test of recent arsenic taking. Such a proportion in the whole lock may be consistent with the presence of an amount such as 1-30th grain per lb. in a particular one or two inches. The latter quantity, if detected, would afford a strong indication of the patient's past history as regards arsenic.

The time available for this inquiry did not enable a new and more satisfactory series of hair specimens from alcoholic neuritis cases to be collected and examined in the light of the experience gained when all the results from persons taking arsenic medicinally had been put together and studied. It may, however, be useful to note the following points which it seems important to regard in future examinations of hair from cases of peripheral neuritis. In order that the hair examined may correspond approximately with the period in which it is suspected that arsenic may have been taken, the hair specimen, in the case of men, should be obtained as early as possible. If it is not taken for several months after the onset of the illness it will probably be hair which has grown at a time when the condition of the patient as regards arsenic and alcohol have been quite different from those in which he contracted the disease. In the case of women, it is perhaps less important to take the specimen early, as their hair is long and can be examined in sections; for example, a lock can be divided into portions (a) 0-2in., (b) 2-4in., (c) 4-7in. from the scalp. But if this is done it is essential to get a lock sufficiently thick to allow each of these portions to be as much as 2 grammes in weight. A lock which at the scalp end is as thick as the little finger will ordinarily be sufficient for the purpose. It is best obtained by "thinning" the hair from different parts of the head.

July, 1903. G. S. B.

II.—REPORT BY MR. R. F. WOOD SMITH ON METHODS ADOPTED IN TESTING SPECIMENS OF HAIR FOR ARSENIC

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In general principle the method of procedure was in each case to destroy the organic matter in a weighed sample of hair in such a manner as to retain the arsenic in the inorganic residue, and then to examine this residue by means of the Marsh-Berzelius apparatus. In detail I give herewith accounts of the various operations necessary to attain that end.

Collection and Reception of Samples.

In nearly all cases I received these from Dr. Buchanan in white envelopes of a strong texture and suitable size, and I feel satisfied that the samples sent in this manner always arrived in a dry and sound condition. In a few instances I personally collected the samples, which were then carefully wrapped up in stout white paper.

Weight of Samples Analysed.

I found that the most suitable quantity for work was from 4 to 5 grammes, but as it was found impossible to rely upon obtaining such amounts for analysis, I fell back upon 2 grammes as being a reliable quantity to employ. When 2 grammes were taken I satisfied myself that, with my apparatus, good approximations can be assessed down to 1-100th grain of As_2O_3 per lb. of sample, and a rough assessment even down to 1-400th grain per lb. Since, however, the samples were even smaller than the 2 grammes in some instances, I have, for the sake of uniformity, referred to all proportions under about 1-250th grain per lb. as "a trace." Instances where considerably less than 2 grammes were available, and where in consequence the delicacy of the estimation was diminished, have been noted in my reports.

Oxidisation of Samples.

As nearly as possible 2 grammes of the hair to be tested were weighed out on a paper tray and transferred to a Jena glass flask of about 250 c.c. capacity. Upon the hair were then poured about 30 c.c. of strong arsenic-free nitric acid, and then 4 c.c. of strong arsenic-free sulphuric acid. The contents of the flask were then warmed on a sand bath under a funnel hood within the fume chamber until rapid oxidation set in, when, after the first violence of the action had subsided, the temperature was raised so as to thoroughly boil the liquor. After continued boiling the liquor darkens, when more nitric acid must be added, but a point was always finally arrived at when only clear colourless vitriol remained, and in which was dissolved all the arsenic which might have been in the sample taken.

This vitriol liquor was then treated with five or six times its bulk of water, and again boiled down to the same consistency, this operation being advisable to guard against the possibility of nitrogen compounds obtaining access to the Marsh apparatus. This re-boiled liquor was now ready for direct analysis.

Marsh Apparatus and Re-agents.

A small flask having a detachable ground-in separator and side tube of about 100 c.c. capacity was employed, an absorption tube containing lead acetate paper and calcium chloride being attached to the side tube, which, as usual, formed the delivery tube to the depositing tube.

15-20 grammes of arsenic-free zinc were introduced into the flask, and the apparatus set in operation by the employment of 1 in 4 arsenic-free sulphuric acid.

I had very little difficulty in obtaining arsenic-free sulphuric and nitric acids, but only a very small proportion of the zinc sold is really free, and considerable quantities had to be tested before a reliable metal could be found. Blank experiments on the re-agents were constantly being carried out during the series of analyses, and these blank analyses were performed by boiling down as much nitric acid and sulphuric acid as would be actually employed in the experiments proper and then testing the obtained vitriol in the Marsh apparatus.

Standard mirrors with known amounts of arsenic were frequently prepared, and compared with one another. In this way the "sensitiveness" of the zinc was frequently checked.

The Marsh Experiment.

This was performed in the apparatus described in the ordinary manner; that is, after introducing the necessary amount of acid to fill the whole apparatus with hydrogen and maintain a steady flame of about 2 to 3 m.m. in length at the outlet jet, the diluted vitriol-liquor referred to (or, in the case of a standard preparation, the desired amount of arsenical solution) was introduced into the apparatus, and the action continued for 18 to 20 minutes, when a fresh deposit tube was fitted to the apparatus and the action continued for a further 10 minutes.

Comparison with Standards.

In dealing with the vitriol liquors obtained from hair samples, unless I had reason to the contrary, I always measured half the liquor obtained after dilution for a first test, as very heavy mirrors were often obtained, and I was thus enabled in such cases to repeat the operation on a small quantity of the residue in order to arrive at a mirror adequate for comparison with the standards. I never have more than seven or eight of these standard tubes, and their range is only from 1-100,000th grain to 20-100,000th grain, as I prefer to be constantly renewing all of these, and to bring by dilution experimental quantities into this range.

For instance, I have often obtained from half the vitriol liquor a dark mirror, which I judged to be three or four times greater than my largest standard mirror. Then I have repeated the experiment, using a suitable fraction of the remaining portion. The obtaining of the large mirrors, however, was always a most useful qualitative test, and the finest crystals could be obtained by burning the deposit within the tubes; in other words, the proportions of arsenic then were always judged, not from heavy, but from medium-sized mirrors, but the corroboration by burning, on the other hand, was performed, where possible, on the largest deposits.

In carrying out all the experiments I took every precaution which I could think of as necessary to secure that the mirror obtained represented accurately and comparably the arsenic derived from the hair, and that no error should arise through any accidental contamination. For example, in diluting the vitriol liquors after oxidation, I carried out the measurements in a small cylinder, and took very small quantities by means of a graduated capillary pipette. More accurate amounts might have been taken by transferring the liquor to a graduated flask, and then measuring from a burette, but, on the other hand, the chances of contamination would have been much greater, and I should have felt less confident of the value of the results.

Estimating the quality of the mirror by comparison with standards necessarily introduces an element of uncertainty. I did not think it necessary or advisable to attempt minute differentiation—for example, as between 1-70th and 1-75th grain per lb.—but rather I sought to obtain a reliable approximate estimate by comparison with standard mirrors which presented substantial contrasts.

R. F. Wood Smith.

April, 1903.

III.—DETAILED TABULAR STATEMENTS OF CASES AND RESULTS.

These will be found below in Tables A to F:—

A

Appendix 32.

APPENDIX, No 32.

TABLE A.—HAIR FROM MALES NOT HAVING RECENTLY TAKEN ARSENIC MEDICINALLY.

Reference No.	Initials.	Age.	Results of analysis. (As_2O_3 in grs. per lb. of hair.)	Origin of sample.	Remarks.
2	G. B. B.	4	None.	Private source	
3	Dr. P.	58	$\frac{1}{200}$	Private source	
4	A. H. F	34	Trace.*	Private source	
7	A. B.	20	Free	Guy's	
–	R. S.	?	$\frac{1}{150}$	Private source	Takes about 1 quart of beer daily.
26	A. E. G.	44	Free	Private source	
73a	N. H.	40	$\frac{1}{150}$	Paddington	
74a	J. D.	19	Trace	Paddington	
75a	J. A.	26	Trace	Tooting	
76a	J. T.	34	Free	Tooting	
77a	H. S.	26	$\frac{1}{50}$	Tooting	*See note*, Table C.
78a	F. S.	37	$\frac{1}{150}$	Tooting	
79a	F. R.	30	Trace	Tooting	
80a	A. P.	16	Trace	Tooting	
81a	T. N.	31	Trace	Tooting	
82a	W. N.	31	Free	Tooting	
83a	W. K.	42	Free	Tooting	
93a	R. H. C.	50	$\frac{1}{25}$	St. George's Infirmary.	*See note*, Table E.
94a	F. A.	42	Free	St. George's Infirmary.	
95a	G. H.	49	Trace	St. George's Infirmary.	
96a	A. H.	46	Free	St. George's Infirmary.	
97a	J. B.	41	$\frac{1}{100}$	St. George's Infirmary.	
100a	J. S.	36	Free	St. George's Infirmary.	
101a	H. L.	51	Trace	St. George's Infirmary.	
102a	W. D.	47	Free	St. George's Infirmary.	
103a	J. S.	29	Free	St. George's Infirmary.	
106a	F. H.	45	Trace	St. George's Infirmary.	
107a	J. O.	61	Trace	St. George's Infirmary.	
108a	C. B.	36	Free	St. George's Infirmary.	

APPENDIX, No. 32—*continued.* Appendix 32

MALE HAIR DRESSERS SAMPLES (no knowledge as to Arsenic taken).

Sample A (unwashed)	$\frac{1}{200}$ gr. per lb.	Sample G	Free.
„ „ (washed with water)	$\frac{1}{250}$ „ „	„ H	$\frac{1}{200}$ gr. per lb.
„ B	Free.	„ I	$\frac{1}{250}$ „ „
„ C	Free.	„ J	below $\frac{1}{300}$ „ „
„ D (unwashed)	$\frac{1}{150}$ gr. per lb.	„ K	Free.
„ „ (washed with water)	$\frac{1}{150}$ „ „	„ M	Free.
„ E	$\frac{1}{500}$ „ „	„ N	Free.
„ F	Free		

In all cases "trace" signifies an amount of arsenic certainly below $\frac{1}{10}$ grain per lb. (0·57 per million).

B

TABLE B.—HAIR FROM FEMALES NOT HAVING RECENTLY TAKEN ARSENIC MEDICINALLY

Reference No.	Initials.	Age.	Results of Analysis. (As_2O_3 in grs. per lb. of hair.)	Origin of sample.
1	E. B.	15	$\frac{1}{250}$	Guy's.
5	Mrs. H.	33	Free.	Private source.
—	W. F.	?	Trace.*	Private source.
—	M. S.	?	Trace.	Private source.
69*a*	E. H.	43	Free.	Paddington.
71*a*	A. P.	35	Trace.	Paddington.
72*a*	E. D.	41	Trace.	Paddington.
84*a*	M. G.	27	Trace.	Tooting.
85*a*	M. H.	21	Trace.	Tooting.
86*a*	A. M.	20	Free.	Tooting.
87*a*	M. P.	35	Free.‡	Tooting.
88*a*	E. M.	28	Free.‡	Tooting.
14	M. F.	23	$\frac{1}{40}$†	Guy's.

* In all cases "trace" signifies an amount below $\frac{1}{10}$ grain per lb. (0·57 per million).

† When this sample was collected, the patient had been taking 45 minims of liq. arsenicalis daily for a fortnight. In cutting the hair specimen, half an inch of hair was left close to the head as it was thought that in this way the sample would represent the period during which no arsenic was taken.

‡ Less than 1 gramme of these samples available for analysis.

APPENDIX, No. 32—*continued.*

C

TABLE C.—MALE CASES OVER 15 YEARS OF AGE TAKING OR HAVING LATELY DISCONTINUED TAKING LIQUOR ARSENICALIS.

Reference No.	Hospital or Infirmary.	Initials.	Age.	Disease.	Daily Doses of liquor arsenicalis (1 per cent. solution of arsenious oxide) taken and Dates.	Approximate Summary of Daily Dose and Period of Arsenic-taking.	Results, As_2O_3 in grs. per lb. of hair.	Result of Examination of Control Sample, if any, obtained before Arsenic began to be taken.	Special points as to Sample noted, *e.g.*, weight taken, abundance, &c.
8	Guy's	W. C.	51	Splenic anæmia	12 min. daily for 10 days, from 31 May to 10 June 21 min. daily for 6 days, from 10 June to 16 June. 30 min. daily for 30 days, from 16 June to 16 July. Omitted altogether for 10 days, from 16 July to 26 July. 12 min. daily for 25 days, from 27 July to 21 August.	18 min., 12 weeks (average); and discontinued 10 days.	over $\frac{1}{5}$	—	Hair cut to within $\frac{1}{16}$ inch from scalp.
13	Guy's	F. R.	39	Headache and polyuria ? diabetes insipidus.	15 min. daily for 46 days, from 7 July to 22 August	15 min., 6½ weeks	$\frac{1}{10}$	—	—
6	Saint Bartholomew's.	R. J. G.	47	?	9 min. daily for 3½ months	9 min., 16 weeks	$\frac{1}{5}$	—	—
21	Saint Bartholomew's.	A. S.	26	Splenic leukæmia	15 min. daily for 10 days, from 13 Oct. to 23 Oct.	15 min., 1½ weeks	$\frac{1}{100}$	—	—
24	Saint Bartholomew's.	A. W.	56	Lichen planus	10 min. daily for 39 days, from 31 August to 9 Oct.	10 min., 5½ weeks	$\frac{1}{50}$	—	—
25	Saint Bartholomew's.	A. E. A.	15	Bullous eruption of uncertain nature.	9 min. daily for 15 days, from 9 Sept. to 24 Sept. 18 min. daily for 6 days, from 24 Sept. to 30 Sept. 24 min. daily for 8 days, from 30 Sept. to 8 Oct.	15 min., 1 month (average); discontinued 16 days.	Trace*	—	—
105	"	"	"	" "	9 min. daily for 41 days, from 24 Oct. to 5 Dec.	Besides above, 9 min. for further 6 weeks.	$\frac{1}{10}$	—	—
30	Middlesex	A. A.	15	Chorea	12 min. daily for 2 days, from 1 Nov. to 3 Nov. 15 min. daily for 2 days, from 3 Nov. to 5 Nov. 18 min. daily for 1 day, from 5 Nov. to 6 Nov. 21 min. daily for 3 days, from 6 Nov. to 9 Nov. 24 min. daily for 17 days from 9 Nov. to 26 Nov. Discontinued 7 days from 26 Nov. to 3 Dec.	22 min., 3 weeks; and discontinued 1 week.	$\frac{1}{25}$	—	—
32	Paddington	T. B.	20	Pleurisy	9 min. daily for 26 days from 13 Nov. to 9 Dec.	9 min., 4 weeks	under $\frac{1}{150}$	—	—
33	Paddington	G. C.	70	Ulcerated leg	9 min. daily for 26 days from 13 Nov. to 9 Dec.	9 min., 4 weeks	under $\frac{1}{150}$	—	For further sample, *see* No. 47.

34	Paddington	D. W.	71	Bronchitis	9 min. daily for 156 days, from 6 July to 9 Dec.	9 min., 22 weeks	$\frac{1}{4}$	—	For further sample *see* No 68.
35	Paddington	H. B.	42	Tabes dorsalis	9 min. daily for 38 days, from 6 Oct. to 13 Nov. Discontinued for 26 days, from 13 Nov. to 9 Dec.	9 min., 5 weeks; and discontinued 4 weeks.	$\frac{1}{10}$	—	——
36	Paddington	F. B.	52	Paraplegia	9 min. daily for 27 days, from 29 July to 25 August Discontinued for 106 days, from 25 August to 9 Dec.	9 min., 4 weeks; and discontinued 15 weeks.	$\frac{1}{40}$	—	——
37	Marylebone	W. J.	33	Exfoliating dermatitis.	12 min. daily for 41 days, from 1 Nov. to 10 Dec. Also 15 min. liq. Donovani (= 3½ min. liq. arsenicalis)—for 141 days, from 7 June to 31 Oct.	Various amounts, 6 months.	$\frac{1}{10}$	—	——
38	Marylebone	W. M.	64	Eczema	9 min. daily for 11 days, from 30 Nov. to 10 Dec.	9 min., 2 weeks	$\frac{1}{15}$	—	Had been admitted to hospital about 3 weeks before sample was taken. Had medicine before admission.
39	Marylebone	W. P.	50	Aneurism	9 min. daily for 73 days, from 29 Sept. to 10 Dec.	9 min., 10 weeks	$\frac{1}{10}$	—	
41	Clapham	F. N.	63	Chronic eczema	9 min. daily for 36 days, from 14 Nov. to 19 Dec.	9 min., 5 weeks	$\frac{1}{40}$	—	——
45	Tooting	S. C.	37	Phthisis	6 min. daily for 51 days, from 9 Nov. to 30 Dec.	6 min., 7 weeks	$\frac{1}{60}$	—	Hair about 1½ in. long.
47	Tooting	J. D.	50	Asthma	12 min. daily for 65 days, from 13 Oct. to 16 Dec. Discontinued for 14 days, from 16 Dec. to 30 Dec.	12 min., 9 weeks; and discontinued 2 weeks.	$\frac{3}{4}$	—	-
52	Fulham	W. B.	71	Phthisis	12 min. daily for 85 days, from 3 Oct. to 26 Dec. Discontinued for 13 days, from 26 Dec. to 8 Jan. 1903.	12 min., 12 weeks; and discontinued 2 weeks.	$\frac{1}{100}$	—	Small sample of white hair.
57	Islington	F. N.	29	Pemphigus	12 min. daily for 2 days, from 2 Dec. to 4 Dec. 18 min. daily for 4 days, from 4 Dec. to 8 Dec. 24 min. daily for 15 days, from 8 Dec. to 23 Dec. Discontinued for 23 days, from 23 Dec. to 15 Jan. 1903.	22 min., 3 weeks (average); and discontinued 3 weeks.	$\frac{1}{12}$	—	——
59	Islington	E. B.	67	Dermatitis	12 min. daily for 7 days, from 28 July to 4 August 18 min. daily for 154 days, from 4 August to 5 Jan. 1903. Discontinued for 9 days, from 5 Jan. to 14 Jan. 1903.	18 min., 23 weeks; and discontinued 1 week.	$\frac{1}{4}$		
62	Lambeth	W. J.	17	Morb. cordis	9 min. daily for 21 days, from 15 Dec. to 5 Jan. 1903 15 min. daily for 7 days, from 5 Jan. to 12 Jan. 1903. Discontinued for 4 days, from 12 Jan. to 16 Jan. 1903.	10 min., 1 month; and discontinued 4 days.	$\frac{1}{10}$	—	Short hair. Sample 1·68 grammes.
67	Paddington	G. C.	70	Ulcerated legs	9 min. daily for 92 days, from 13 Nov. to 2 Feb. 1903	9 min., 3 months	$\frac{1}{2}$	On December 9 under $\frac{1}{250}$. *See* No. 33.	——
68	Paddington	D. W.	71	Bronchitis	9 min. daily for 211 days, from 6 July 1902 to 2 Feb. 1903	9 min., 7 months	$\frac{1}{2}$	*See* 34, above	——

* In all cases "trace" signifies an amount below 1-250th grain per lb. A reference table showing the equivalents in parts per million of fractions of a grain per pound will be found at the end of this volume.

APPENDIX, No. 32—*continued.*

C—*continued.*

TABLE C.—Male Cases over 15 Years of Age taking or having lately discontinued taking Liquor Arsenicalis—*continued.*

Reference No.	Hospital or Infirmary.	Initials.	Age.	Disease.	Daily Doses taken and Dates.	Approximate Summary of Daily Dose and Period of Arsenic-taking.	Results, $As_2 O_3$ in grs. per lb of hair.	Result of Examination of Control Sample, if any, obtained before Arsenic began to be taken.	Special points as to Sample noted, *e.g.*, weight taken, abundance, &c.
73b	Paddington	N. H.	40	Tabes dorsalis	9 min. daily for 55 days, from 9 Dec. 1902 to 2 Feb. 1903	9 min., 2 months	$\frac{1}{15}$	$\frac{1}{150}$	Probably sample includes hair grown before arsenic was begun.
74b	Paddington	J. D.	19	Morbus cordis	9 min. daily for 55 days, from 9 Dec. 1902 to 2 Feb. 1903	ditto	$\frac{1}{8}$	Trace.	ditto - ditto.
75b	Tooting	J. A.	26	Epilepsy	9 min. daily for 55 days, from 1 Jan. to 24 Feb.	ditto	$\frac{1}{50}$	Trace.	Second sample taken from same spot as control, clippers used each time.
76	Tooting	J. T.	34	ditto	ditto - ditto	ditto	$\frac{1}{5}$	Free.	ditto - ditto.
77	Tooting	H. S.	26	ditto	ditto - ditto	ditto	$\frac{1}{20}$	$\frac{1}{50}$	For two months before control sample was taken this man was taking 3 drachms of Easton's Syrup daily.
78	Tooting	F. S.	37	ditto	ditto - ditto	ditto	$\frac{1}{10}$	$\frac{1}{150}$	Second sample taken from same spot as control.
79	Tooting	F. R.	30	ditto	ditto - ditto	ditto	$\frac{1}{8}$	Trace.	ditto - ditto.
80	Tooting	A. P.	16	ditto	ditto - ditto	ditto	$\frac{1}{20}$	Trace.	ditto - ditto.
81	Tooting	T. N.	31	ditto	ditto - ditto	ditto	$\frac{1}{5}$	Trace.	ditto - ditto.
82	Tooting	W. N.	31	ditto	ditto - ditto	ditto	$\frac{1}{5}$	Free.	ditto - ditto.
83	Tooting	W. K.	42	ditto	ditto - ditto	ditto	$\frac{1}{10}$	Free.	ditto - ditto.

D

TABLE D.—FEMALE CASES OVER 15 YEARS OF AGE TAKING OR HAVING LATELY DISCONTINUED TAKING LIQUOR ARSENICALIS.

Reference No.	Hospital or Infirmary.	Initials.	Age.	Disease.	Daily Doses taken and Dates.	Approximate Summary of Daily Dose and Period of Arsenic-taking.	Results, As_2O_3 in grains per lb. of hair. Roots.	Tips.	Whole Length.	Result of Examination of Control Sample, if any, obtained before Arsenic began to be taken.	Special points as to Sample noted, Instructions given to Analyst, &c.
16	Croydon	M. K. A.	32	Slight eczema of neck and chest.	10 min. liq. sodii arsenatis, daily for 8 weeks	10 min., 2 months (liq. sodii arsenatis.)	Trace.	Free.	–	—	Divided into (*a*) about 2 ins. from scalp end, (*b*) rest.
17	Guy's	E. C.	43	Osteoarthritis	9 min. daily for 56 days	9 min., 2 months	1/80	1/120	–	—	Divided into (*a*) about 1½ in. from scalp end, (*b*) rest.
27	Middlesex	M. G.	55	?Pernicious anæmia	7½ min. daily for 4 days, from 8 Nov. to 11 Nov. 15 min. daily for 3 days, from 12 Nov. to 14 Nov. 22½ min. daily for 2 days, from 15 Nov. to 16 Nov. 30 min. daily for 17 days, from 17 Nov. to 3 Dec.	24 min., 1 month (average).	1/120	Trace.	–	—	Divided into (*a*) root portion, (*b*) rest of lock.
28	Middlesex	M. M.	22	Acute rheumatism	12 min. daily for 22 days, from 10 Nov. to 3 Dec.	12 min., 3 weeks	1/150	Trace.	–	—	ditto ditto.
29	Middlesex	A. L.	19	Sub-acute rheumatism.	12 min. daily for 25 days, from 5 Nov. to 7 Nov. and from 12 Nov. to 3 Dec.	12 min., 4 weeks	–	–	Free.	—	Whole lock was tested. Very little of sample could have grown during the 4 weeks.
31	Paddington	S. M.	43	Chorea	9 min. daily for 15 days, from 3 Nov. to 17 Nov. 24 min. daily for 20 days, from 18 Nov. to 9 Dec.	18 min., 5 weeks	–	–	Trace.	—	Whole lock tested. Compare 66 below for another sample from this case.
40	Marylebone	S. C.	43	Rheumatism	9 min. daily for 253 days, from 21 Mar. to 29 Nov. Discontinued 13 days, from 29 Nov. to 12 Dec.	9 min., 9 months; and discontinued, 2 weeks.	1/10	Free.	(Middle) 1/100	—	Divided into (*a*) 4 ins. at root end, (*b*) 4 to 8 ins. from root, (*c*) rest of lock.
46	Tooting	H. L.	66	Asthma	12 min. daily for 131 days, from 4 Feb. to 15 June Discontinued 37 days, from 16 June to 23 July. 12 min. daily for 19 days, from 24 July to 11 August. Discontinued 44 days, from 12 Aug. to 23 Sept. 12 min. daily for 87 days, from 24 Sept. to 19 Dec. Discontinued 11 days, from 20 Dec. to 30 Dec.	12 min., 8 months; and discontinued, 3 months.	–	–	1/10	—	Sample weighed ·86 grm. only.
48	Fulham	E. H.	38	Epilepsy	10 min. daily for 140 days, from 16 Aug. 1902 to 3 Jan. 1903.	10 min., 20 weeks	1/40	Free.	–	—	Lock about 10 ins. long. Divided into (*a*) root half, (*b*) ends.

APPENDIX, No. 32—*continued.*

D—*continued.*

TABLE D.—Female Cases over 15 Years of Age taking or having lately discontinued taking Liquor Arsenicalis—*continued.*

Reference No.	Hospital or Infirmary.	Initials.	Age.	Disease.	Daily Doses taken and Dates.	Approximate Summary of Daily Dose and Period of Arsenic-taking.	Results, As_2O_3 in grains per lb. of hair.			Result of Examination of Control Sample, if any, obtained before Arsenic began to be taken.	Special points as to sample noted, Instructions given to Analyst, &c.
							Roots.	Tips.	Whole Length.		
49	Fulham	L. W.	15	Chorea	16 min. daily for 64 days, from 6 Nov. 1902 to 9 Jan. 1903.	16 min., 9 weeks	$\frac{1}{40}$	–	–	—	Long lock about 4 ins. from scalp end tested.
50	Fulham	J. D.	34	Epilepsy	6 min. daily for 54 days, from 16 June to 8 Aug. Discontinued for 5 days, from 8 Aug. 13 Aug. 10 min. daily for 153 days, from 13 Aug. 1902 to 8 Jan. 1903.	9 min., 30 weeks	$\frac{1}{40}$	Trace	–	—	Lock about 12 ins. long. Divided into (*a*) root half, (*b*) rest.
51	Fulham	S. R.	56	Lupus	12 min. daily for 146 days, from 16 Aug. 1902 to 8 Jan. 1903.	12 min., 5 months	$\frac{1}{10}$	–	–	—	Only 4 to 5 ins. at root end tested.
56	Islington	L. J.	34	Psoriasis	9 min. daily for 26 days, from 12 Dec. 1902 to 7 Jan. 1903. 15 min. daily for 8 days, from 8 Jan. to 15 Jan.	10 min., 5 weeks	$\frac{1}{8}$	$\frac{1}{100}$	–	—	Divided into (*a*) 3 ins. at root end, (*b*) rest.
58	Islington	M. J.	54	Myxœdema	9 min. daily for 203 days, from 11 June to 29 Dec. Discontinued 15 days, from 30 Dec. to 13 Jan.	9 min., 29 weeks; and discontinued, 2 weeks.	–	–	$\frac{1}{8}$	—	Small sample, weighed ·48 gramme.
60	Lambeth	E. C.	33	Phthisis	9 min. daily for 36 weeks, from 1 May 1902 to 9 Jan. 1903.	9 min., 36 weeks	–	–	$\frac{1}{5}$	—	About 7 ins. lock.
61	Lambeth	G. B.	19	ditto	9 min. daily for 1 month, from 9 Dec. 1902 to 19 Jan. 1903.	9 min., 1 month	Trace.	Trace.	–	—	Thick lock about 18 ins. long. Divided into (*a*) 2 ins. at root end, (*b*) rest.
63	Lambeth	M. W.	20	Anæmia	12 min. daily for 5 days, from 23 Oct. to 28 Oct. Discontinued 10 days from 28 Oct. to 7 Nov. 12 min. daily for 20 days from 8 Nov. to 28 Nov. Discontinued 49 days, from 29 Nov. to 16 Jan.	12 min., 3½ weeks; and discontinued, 7 weeks.	$\frac{1}{15}$	$\frac{1}{40}$	–	—	Large lock Divided into (*a*) 3 ins. at root end, (*b*) rest, 9 ins.
64	Lambeth	M. P.	40	Neurasthenia	9 min. daily for 32 days, from 31 Oct. 1 Dec. 15 min. daily for 15 days, from 2 Dec. to 16 Dec. Discontinued 3 weeks from 16 Dec. to 7 Jan.	11 min., 7 weeks	$\frac{1}{2}$	–	–		Small, thick lock. 4 ins. at root end tested only.

65	Lambeth	L. F.	46	Tuberculur hip	9 min. daily for 1 month, from 9 Nov. to 9 Dec. Discontinued 1 month, from 9 Dec. to 9 Jan.	9 min., 1 month	$\frac{1}{50}$	Trace.	-	—	Long lock. Divided into (a) 3 ins. at root end, (b) next 2 ins
66	Paddington	S. M.	43	Chorea	9 min. daily for 16 days, from 3 Nov. to 18 Nov. 24 min. daily for 49 days, from 19 Nov. to 6 Jan. Discontinued 17 days, from 6 Jan. to 23 Jan. 9 min. daily for 9 days, from 23 Jan. to 1 Feb.	Varying amounts at intervals for 8 weeks since last collection (*see* sample 31).	-	-	$\frac{3}{10}$	—	Sample is of quite short hair.
696	Paddington	E. H.	43	Eczema	9 min. daily for 55 days, from 9 Dec. 1962 to 2 Feb. 1963.	9 min., 2 months	-	-	$\frac{1}{8}$	Free	Hair taken from same spot as control: length 1¼ ins.
716	Paddington	A. P.	35	Phthisis	9 min. daily for 55 days, from 9 Dec. to 2 Feb.	9 min., 2 months	Trace.*	-	-	Trace	Length taken 21 ins. Tested only 2 ins. at root end.*
729	Paddington	E. D.	41	Right hemiplegia	9 min. daily for 25 days, from 9 Dec. to 3 Jan. Discontinued 6 days, from 3 Jan. to 9 Jan.	9 min., 3½ weeks; and discontinued 1 week.	$\frac{1}{30}$	-	-	Trace	Tested not more than about 1 inch at root end.
84	Tooting	M. G.	27	Epilepsy	9 min. daily for 55 days, from 1 Jan. to 24 Feb.	9 min., 2 months	$\frac{1}{25}$	-	-	Trace	Tested only about two inches from root end.
85	Tooting	M. H.	21	Epilepsy	9 min. daily for 25 days, from 1 Jan. to 25 Jan. Discontinued 1 month, from 25 Jan. to 24 Feb.	9 min., 1 month	$\frac{1}{20}$	-	-	Trace	- - ditto.
86	Tooting	A. M.	20	Epilepsy	9 min. daily for 55 days, from 1 Jan. to 24 Feb.	9 min., 2 months	$\frac{1}{15}$	-	-	Free	- - ditto
87	Tooting	M. P.	35	Epilepsy	6 min. daily for 55 days, from 1 Jan. to 24 Feb.	6 min., 2 months	Trace.	-	-	Free	Thin lock, 81 gramme only examined.
88	Tooting	E. M.	28	Epilepsy	9 min. daily for 55 days, from 1 Jan. to 24 Feb.	9 min., 2 months	$\frac{1}{25}$	-	-	Free	Tested only about two inches from root end.

* Another lock taken 3 months after liquor arsenicalis discontinued showed: 1½ inches at root, $\frac{1}{25}$th; next 1½ inches, $\frac{1}{50}$th; next 2 inches, $\frac{1}{100}$th grain; remainder free.

APPENDIX, No. 32—*continued.*

TABLE SHOWING CASES OF CHILDREN UNDER 15 YEARS OF AGE TAKING OR HAVING LATELY DISCONTINUED TAKING LIQUOR ARSENICALIS.

Reference No.	Hospital or Infirmary.	Initials.	Age.	Disease.	Daily Dose taken and Dates.	Approximate Summary of Daily Dose and Period of Arsenic-taking.	Results, As$_2$O$_3$ in grs. per lb. of hair.	Results of Examination of Control Sample, if any, obtained before Arsenic began to be taken.	Special points as to Sample noted, instructions to Analyst, &c.
6	Guy's	D. G.	12	Chorea	6 min. daily for 60 days	6 mins., 2 months	Scalp portion, Trace; ends, Trace.	—	Divided into two portions.
12	Guy's	E. D.	11	Chorea	7½ min. daily for 1 month, from 28th Oct. to 23rd Nov. 1901 Discontinued from 23rd Nov. to 12th May 1902. 7½ min. daily for 3½ months from 12th May to Aug. 25.	7½ min., 4½ months, and discontinued 24 weeks.	1/80	—	Hair not divided.
15	Guy's	M. W.	12	Chorea, rheumatism	7½ min. daily for 150 days 15 min. daily for 2 days. 30 min. daily for 3 days.	8 min. 5 months (average).	1/25	—	ditto.
18	Croydon	D. T.	11	Chorea	24 min. daily for 42 days Discontinued for 35 days.	24 min. 6 weeks, and discontinued 5 weeks.	(*a*) Free (*b*) Free. (*c*) Scalp 1/150 tips a trace.	—	(*a*) Small specimen cut 2 ins. from head. (*b*) Small specimen about 3 in. hair cut close to head. (*c*) Large sample take 1½ in. near head separately. Sample (*a*) weighed ·35 gramme only; (*b*) ·15 gramme only; (*c*) scalp 1·62 grammes; tips 3·4 grammes.
19	St. Bartholomew's.	A. M.	7	Chorea	15 min. daily for 3 days 18 min. daily for 1 day. 21 min. daily for 14 days.	20 min., 3 weeks (average).	1/30	—	
23	St. Bartholomew's.	C. E.	11	Chorea	9 min. daily for 3 weeks	9 min., 3 weeks	1/150	—	
53	St. George's	E. D.	12	Impetigo	7½ min. daily for 36 weeks, from 2nd May 1902 7th Jan. 1903	7½ min., 36 weeks	1/2	—	
54	Islington	F. W.	13	Chorea	9 min. daily for 5 days, from 5th July to 10th July 15 min. daily for 6 days, from 10th July to 16th July. 21 min. daily for 181 days, from 16th July to 13th Jan. 1903.	20 mins., 6 months	1/2	—	Small specimen.
55	Islington	W. H. J.	8	Scabies	3 min. daily for 14 weeks, from 10th Oct. to 14th Jan. 1903	3 min., 3 months	1/100	—	

TABLE E.—ADDITIONAL SERIES OF SAMPLES FROM MALE CASES TAKING LIQUOR ARSENICALIS IN TOTAL DAILY DOSES OF 3 TO 4½ MINIMS (1 OR 1½ MINIMS THREE TIMES A DAY BEFORE MEALS).

Reference No.	Hospital or Infirmary.	Initials.	Age.	Disease.	Daily Doses taken and Dates.	Approximate Summary.	Results, As_2O_3 in grs. per lb. of hair.	Result of Examination of Control Sample, if any, obtained before Arsenic began to be taken.	Special points as to Sample noted.
93	St. George's Infirmary.	R. H. C.	50	Epilepsy	4½ min. for 67 days, from 28th Feb. to 6th May 1903	4½ min., 9½ weeks	$\frac{1}{25}$	$\frac{1}{25}$ gr.	R. H. C. had been in infirmary (except for one week) since July 1902. No facts could be ascertained which threw light on the amount of arsenic in control sample.
94	St. George's Infirmary.	F. A.	42	Rheumatism	ditto ditto ditto	ditto ditto	Over $\frac{1}{50}$	Free.	
95	St. George's Infirmary.	G. H.	49	Rheumatism	3 min. for 67 days, from 28th Feb. to 6th May 1903	3 min., 9½ weeks	$\frac{1}{10}$	Trace.	——
96	St. George's Infirmary.	A. H.	46	Phthisis, rheumatoid arthritis.	4½ min. for 67 days, from 28th Feb. to 6th May 1903	4½ min., 9½ weeks	$\frac{1}{8}$	Free	A. H. discontinued arsenic May 19th. His hair was cut in ordinary course at beginning of June. A later specimen cut to roots with clippers on June 30th showed a trace of arsenic.
97	St. George's Infirmary.	J. B.	41	Ulcerated leg	3 min. for 67 days, from 28th Feb. to 6th May 1903	3 min., 9½ weeks	$\frac{1}{25}$	$\frac{1}{100}$	
100	St. George's Infirmary.	J. S.	36	Ulcerated leg	ditto ditto ditto	ditto ditto	$\frac{1}{80}$	Free.	
101	St. George's Infirmary.	H. L.	51	Morbus cordis	3 min. for 64 days, from 2nd Mar. to 6th May 1903	3 min. 9 weeks	$\frac{1}{100}$	Trace.	——
102	St. George's Infirmary.	W. D.	47	Locomotor ataxy	3 min. for 67 days, from 28th Feb. to 6th May 1903	3 min., 9½ weeks	$\frac{1}{80}$	Free.	——
103	St. George's Infirmary.	J. S.	29	Epilepsy	4½ min. for 63 days, from 3rd Mar. to 6th May 1903	4½ min., 9 weeks	$\frac{1}{50}$	Free	Another sample tested later, *see* text of Report.
106	St. George's Infirmary.	F. H.	45	Synovitis	1½ min. for 67 days, from 28 Feb. to 6th May 1903	4½ min., 9½ weeks	$\frac{1}{40}$	Trace	——
107	St. George's Infirmary.	J. O.	61	Morbus cordis	3 min. for 67 days, from 28th Feb. to 6th May 1903	3 min., 9½ weeks	Trace.	Trace.	——
108	St. George's Infirmary.	C. B.	36	Bronchitis	3 min. for 64 days, from 2nd Mar. to 6th May 1903	3 min., 9 weeks	$\frac{1}{25}$	Free.	——

APPENDIX, No. 32—*continued.*

F

TABLE F.—ALCOHOLIC NEURITIS CASES RECENTLY ADMITTED TO CERTAIN LONDON HOSPITALS OR INFIRMARIES. (*See* p. 350.)

Reference No.	Hospital, &c.	Initials.	Age.	Sex.	Length of time in Hospital.	Duration of Illness at date of Collection of Specimen.	Form of Alcohol.	Arsenic found. Grains per lb. of hair.	Remarks.
9	London	M. O.	50	F.	3 days	Less than 1 month	Probably chiefly spirits	$\frac{1}{80}$	Whole length examined.
10	London	E. S.	48	F.	2 days	Less than 2 months	Beer	Trace.	" "
11	London	L. M.	39	F.	15 days	1 month	Probably brandy and gin	$\frac{1}{150}$	" "
20	St. Bartholomew	L. B.	38	F.	?	?	Beer and gin, freely	$\frac{1}{10}$	" "
89a	Paddington Infirmary	A. D.	44	F.	20 days	3 months	Entirely beer	$\frac{1}{100}$	2 ins. from roots.
89b	" "	"	"	"	"	"	"	$\frac{1}{50}$	The next 2½ ins.
89c	" "	"	"	"	"	"	"	Free.	Rest of the hair.
A.N. 1	Lambeth Infirmary	J. P.	46	M.	57 days	2 months	Beer	$\frac{1}{20}$ (Approximate result: antimony also present.)	About 2 ins. long, rather small sample. Mirror also of antimony.
A.N. 2	St. Pancras Infirmary	L. R.	51	F.	3 months	4 months	Beer and rum	(*a* and *b*) free.	White hair about 13 ins. long, (*a*) root 3 or or 4 ins.; (*b*) rest.
A.N. 3	Fulham Infirmary	M. S.	55	F.	15 days	Less than 1 month	Beer, two glasses daily	(*a*) trace, (*b*) free.	Scanty lock about 12 ins. long, (*a*) root 4 ins. (*b*) rest.
A.N. 4	Fulham Infirmary	J. F.	38	F.	24 days	4 months	Beer	Trace.	Scanty lock about 12 ins. long, not sufficient to examine in sections.
A.N. 5	St. George's Infirmary	F. L.	68	F.	Less than a month.	21 months	Spirits	Free.	Short lock of greyish hair, about 8 ins.
A.N. 6	Fulham Workhouse	H. B.	48	F.	2 days	2 months	Whisky chiefly, a little stout	(*a*) trace, (*b*) trace.	(*a*) 4 or 5 ins. (*b*) rest.
A.N. 7	Lambeth Infirmary	J. C.	46	M.	14 weeks	5 months	Whisky and beer	Free.	Short hair.
A.N. 8	Lambeth Infirmary	E. K.	51	F.	17 days	3 months	Beer	Trace.	Scanty hair about 5 ins. long; whole examined.
A.N. 9	Bethnal Green Infirmary.	C. M.	27	F.	12 days	ditto	Beer and gin	$\frac{1}{100}$	Short lock about 4 ins. long, cut to roots.

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Methods of testing various foods and other samples received from Commission. Purification of reagents, hydrochloric, sulphuric, nitric, sulphurous acids, carbonate of ammonia, potassic chlorate, zinc, etc. Method of estimation, "Marsh" apparatus used, with hydrogen from outside generator. Method of working, preparation of standard mirrors. Methods employed for the extraction of arsenic before "Marshing." Destruction of organic matter by Fresenius-Babo method, Gautier's method, basic method. Suggested simplification of Gautier's method (Appendix 22), pp. 220-6. *See also* (Appendix 25), pp. 262-275, (Appendix 31), pp. 335-344.

DR. MCGOWAN AND MR. FLORIS: METHODS IN TESTING FUEL (IN APPENDIX 23):

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MR. WOOD SMITH: METHODS OF TESTING HAIR FOR ARSENIC:

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MEMORANDA.

TABLE OF EQUIVALENTS OF PARTS PER MILLION AND GRAINS PER GALLON AND GRAINS PER POUND, RESPECTIVELY.

Parts per Million.	Equivalent to Grains per Gallon.	Equivalent to Grains per lb.
·048	·0033 = $\frac{1}{300}$	·00033 = $\frac{1}{3000}$
·05	·0035	·00035
·057	·004 = $\frac{1}{250}$	·0004
·064	·0045	·00045
·071	·005 = $\frac{1}{200}$	·0005
·083	·0058	·00058
·095	·0066 = $\frac{1}{150}$	·00066
·1	·007	·0007
·143	·01 = $\frac{1}{100}$	·001 = $\frac{1}{1000}$
·177	·0124	·00124
·19	·013 = $\frac{1}{75}$	·0013
·22	·015	·0015
·286	·02 = $\frac{1}{50}$	·002
·39	·027	·0027
·476	·033 = $\frac{1}{30}$	·0033 = $\frac{1}{300}$
·5	·035	·0035
·571	·04 = $\frac{1}{25}$	·004 = $\frac{1}{250}$
·714	·05 = $\frac{1}{20}$	·005 = $\frac{1}{200}$
·893	·062 = $\frac{1}{16}$	·0062 = $\frac{1}{160}$
1·0	·07	·007
1·19	·083 = $\frac{1}{12}$	·0083 = $\frac{1}{120}$
1·43	·1 = $\frac{1}{10}$	·01 = $\frac{1}{100}$
1·79	·125 = $\frac{1}{8}$	·0125 = $\frac{1}{80}$
2·38	·166 = $\frac{1}{6}$	·0166 = $\frac{1}{60}$
2·86	·2 = $\frac{1}{5}$	·02 = $\frac{1}{50}$
3·57	·25 = $\frac{1}{4}$	·025 = $\frac{1}{40}$
4·76	·33 = $\frac{1}{3}$	·033 = $\frac{1}{30}$
7·14	·5 = $\frac{1}{2}$	·05 = $\frac{1}{20}$
9·52	·66 = $\frac{2}{3}$	·066 = $\frac{1}{15}$
10·7	·75 = $\frac{3}{4}$	·075
14·29	1·0	·1 = $\frac{1}{10}$
21·43	1·5	·15
25·0	1·75	·175
28·57	2·0	·2 = $\frac{1}{5}$
35·71	2·5	·25 =
42·86	3·0	·3

TABLE OF EQUIVALENTS, &c.—*continued.*

Parts per Million.	Equivalent to Grains per Gallon.	Equivalent to Grains per lb.
71·43	5·0	·5
142·87	10·0	1·0
214·29	15·0	1·5
285·71	20·0	2·0
357·14	25·0	2·5
428·57	30·0	3·0
571·43	40·0	4·0
714·29	50·0	5·0
857·14	60·0	6·0
1000·0	70·0	7·0

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